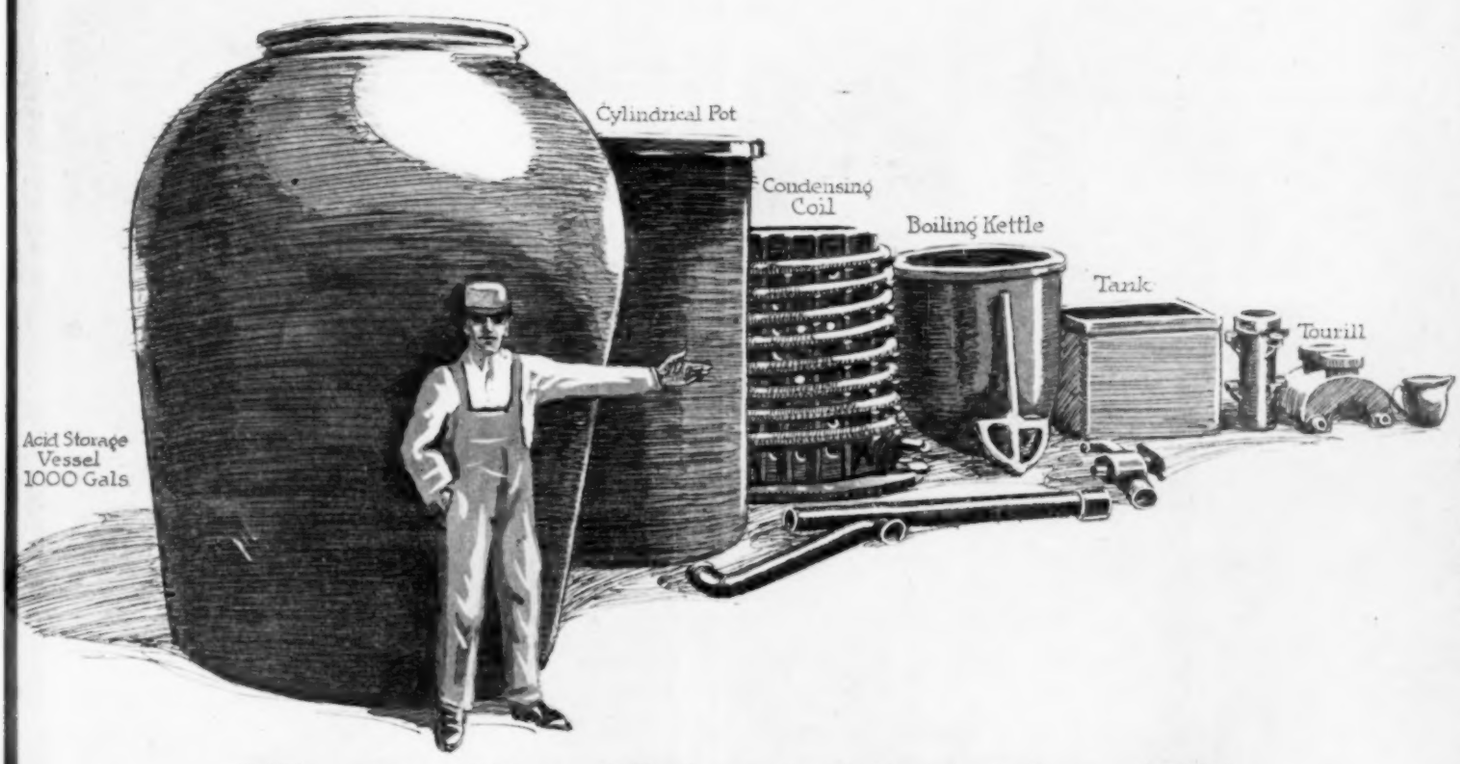
CHEMICAL & METALLURGICAL ENGINEERING



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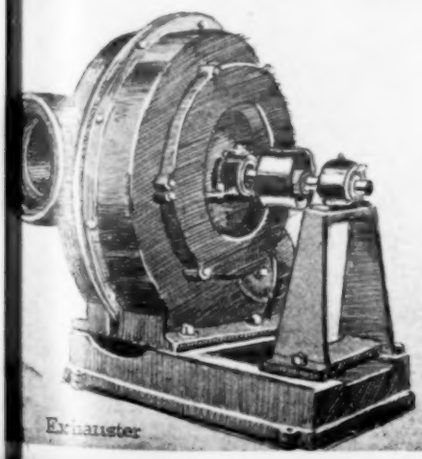
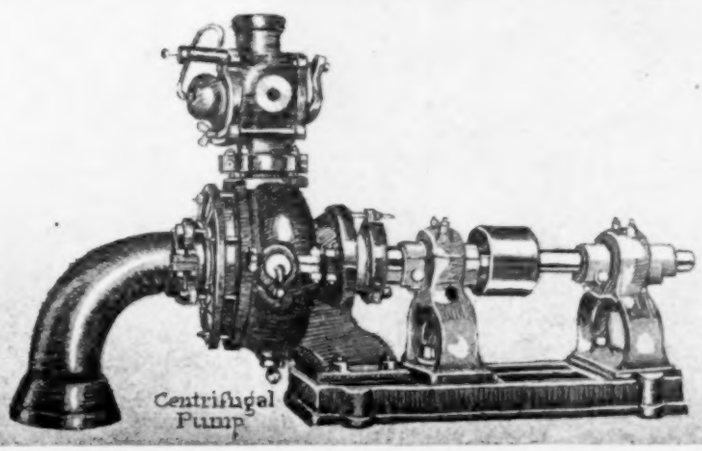


Exhauster



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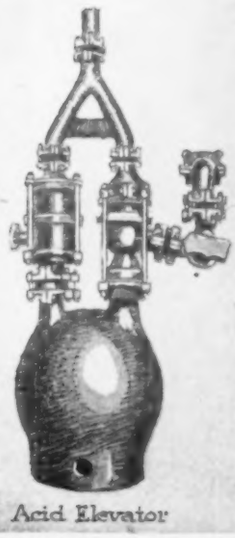

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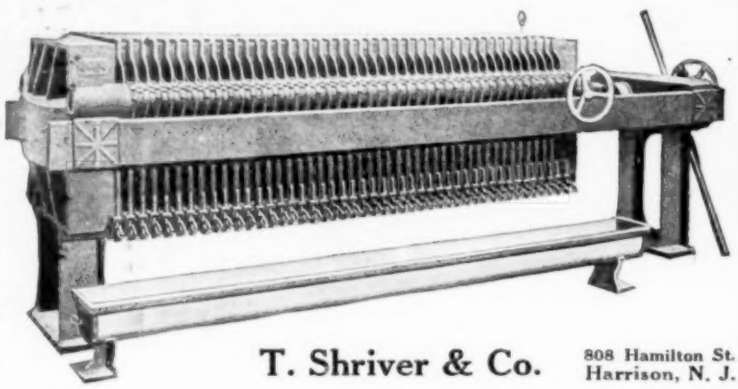

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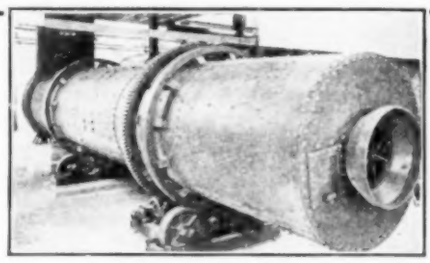

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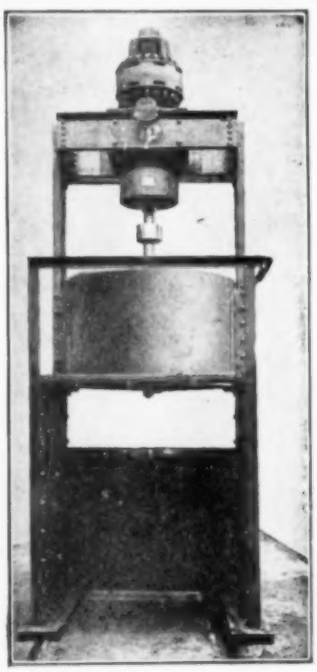

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Volume 23 — New York, July 14, 1920 — *Number* 2

Modern and Ancient Canada

CONSIDERABLE contrast is to be found in the Canada as seen by our colonial grandfathers and the Dominion of today which cannot be ascribed to the natural flow of the sands of time alone. The territorial rivalries between the early settlers of the St. Lawrence and Mississippi river systems and the English Colonies were productive of neighborhood rows and fights that the French priests did not want ever to be buried and forgotten. Two centuries of prayers unanswered have no doubt dampened their passion. But ancient Quebec has given way in political prestige to Montreal, Ottawa, Toronto, peoples to the west, who wish no greater heritage than their present opportunities. Railway transportation, to be sure, has made their growth possible. They did not limit themselves to the use of the bateaux or canoes, but demanded and wrought better ways of transportation.

Those who were fortunate enough to attend the Canadian meeting of the American Institute of Chemical Engineers had the pleasure of seeing modern Canada teeming with ambition. The future city of Belleville may be taken as an example. There cannot be the slightest doubt that it will forge ahead, endowed as it is with creative citizens. Shawinigan Falls has accomplished most, and credit for it should not be of less pride to Canadians because they must share it with their neighbors the citizens of the States. For the very greatest heritages that are theirs also belong to these kinsmen of theirs to the south. The ownership of North America perhaps forms the greatest of all partnerships and the dividend of a greater language, a richer literature and a finer race of men shall be reared from North America, Inc. and Ltd. by the co-operating peoples who loyally love the Maple Leaf or American Eagle.

Strikes, Ammonia And Food Supplies

OCCASIONALLY it is possible to get such concrete evidence of the close interrelation of apparently unrelated matters that a good example is worth recording and pondering. We need an appreciation of the fact that "no man liveth to himself"; but the problem is to get the knowledge where it is most needed and will do the most good. Our present theme—strikes, ammonia and food supplies—may sound as incongruous as the classical "ships and shoes and sealing wax, and cabbages and kings," but the relation is very direct. There is an acute shortage of anhydrous ammonia in the country, and apparently it is a consequence of a series of labor strikes, first in the steel industry, then in the coal mines and finally on the railroads. The immediate effect is a crisis in some places in keeping cold-storage food from spoiling, and extreme measures have been adopted to obtain ammonia wherever possible, even to appealing to the Government.

The steel strike last year was planned far in advance and with great care; but no one imagines for a moment that the leaders calculated the full effect of their acts. But the steel strike closed byproduct coke ovens and diminished the supply of ammonia. The coal strike, likewise, restricted the output of raw material from which our ammonia is recovered. And finally the railroad strikes have made transportation slow and uncertain and have caused embargoes to be placed on such commodities as empty cylinders, thus giving the final touch to a series of events affecting the refrigeration of perishable food. In the face of such conditions the manufacturers of anhydrous ammonia are helpless, but they know the causes of their impotence and it would be well if the whole country could have as keen an appreciation of the situation. The strikes were an offense against society and a menace to the welfare of the people, as the present example shows.

The Education Of the Chemist

THERE is vigor and forceful expression in the last report to the Society for the Promotion of Engineering Education by its Committees on Chemistry. Six important items are discussed constructively: Courses of training for undergraduate degrees; industrial and vocational courses; fifth-year residence courses; conditions in the smaller institutions; aids to training in research; and the future supply of chemists. All are timely and vital.

In discussing instruction in industrial chemistry the committee shows a lively sense of the fitness of things when it says that "much of the time so frequently spent upon the processes given in the textbooks of general industrial chemistry may be better employed in a course which emphasizes the general chemical, engineering and economic problems and their solutions, and which deals with the surmounting of the difficulties encountered in as many of the industries as time will permit. Very little attempt should be made to deal with the technical details of any process." In other words, courses in industrial chemistry should be designed to ground the student in fundamentals rather than attempt to give him a finished technique which, after all, he can never obtain from books or laboratories. School years should be devoted to the study of those things which either cannot or will not be mastered after leaving school.

The committee represents the best thought of the day when it recognizes that "the amount of time necessary to fit a man fully for entering any branch of engineering cannot be crowded into four years." One

solution is "a fifth or graduate year of directed study" which should be spent in an intensive study of methods of chemical research. It is believed that this extra year of study might well be devoted to giving the student an insight into the manner of acquiring and applying chemical knowledge, including the methods of library research. By preference this fifth year should be spent at an institution of recognized advantages, and at some school other than the student's *alma mater*, even though the latter be well equipped.

A real menace to the industrial life of the nation is seen in the increasing difficulty with which young men of ability are attracted to the teaching profession. The business world is offering such high salaries that not only are young graduates deterred from entering educational work with its meager monetary reward, but the best of the younger members of the teaching profession are deserting the schools for industrial laboratories. This means a weakened teaching staff, with consequent deterioration in the product on which further teaching as well as industry must rely. Unless something is done to remedy the situation, we face the prospect of a constantly vanishing quality as well as diminishing quantity in our teaching forces. And since "poor teachers cannot possibly train such men as are needed to enable America to take her natural place among the great industrial nations," it is obvious that more money must be found somewhere for the better compensation of teachers so that the best men can be attractel and held.

The committee makes some very pointed and timely remarks on the subject of chemical research in our colleges, but comment will be reserved for a future time.

Super-Power And Chemistry

THE super-power investigation just beginning under the direction of the U. S. Geological Survey will, we trust, be made sufficiently comprehensive to include certain industrial chemical problems. We refer to the possibility of coking coal and augmenting the supply of byproduct gas in lieu of developing electric power and building transmission lines.

In central and western Pennsylvania, northern West Virginia and western Maryland there is a source of energy. Along the eastern seaboard there is a market clamoring for a supply of energy. The problem is to transfer the resource into useful public utility and transportation supply.

The problem is three-fold. What does it cost to generate the energy in a transportable form; what does it cost to transport this energy to the point of use; and how efficiently can the energy be applied at this destination? There are three forms in which the energy may move: As a solid, coal; as a gas, made either by the byproduct or by other variations of the distillation process; or as the intangible energy, electricity. If we generate electricity we must use it instantly, for it cannot be stored at all; that is, no appreciable percentage of the supply can be stored even by the most extensive use of storage batteries. If gas is the medium, we may store it up to 24 or 48 hours supply, but usually it is impracticable to store even as much as this in large operations. On the other hand, coal can be stored for an entire season or over into a succeeding season if we have a surplus of stock. These facts are so obvious as to have become almost trite in their significance, and yet they are the limiting factor in the swing from solid to gaseous and from gaseous to intangible energy supply.

It is, of course, for each municipality or district to determine which of the three means shall be used, but if proper thought is given to the matter the investigators of super-power possibilities will find that coking of coal and use of gas as one medium of energy transfer is a splendid supplement to the electrical possibilities which their work is certain to encourage. All of our chemical industries will be vitally affected if large-scale coke developments are thus to be considered. The nitrogen resources of the country will be augmented through ammonia production. Tar will afford additional liquid fuel, dyestuff raw materials, road-making material, roofing supplies, and numerous other commodities of large importance. The light oils which would be available from such developments would, of course, be most welcome in the field of gasoline substitutes; and they would also find numerous other applications, especially giving us very comfortable margins in toluol and xylol for military explosives in case of need. Altogether we can see a most attractive future for our industries if this subject receives that attention which we believe it fully deserves.

Technical Libraries An Asset to Industry

WE SOMETIMES wonder whether growing communities realize the value and importance of a technical library to the industrial concerns operating in their midst. Limited observation leads one to give a negative answer; for while libraries are now a common possession of even small towns, it is too often the case that the technical and scientific division suffers from neglect. The need, as we see it just now, is likely to be especially acute in the rapidly developing cities of the West. The East and Middle West are quite well supplied, at least in a few centers that are accessible to large areas; and the facility with which photostat copies and translations can be secured on short notice makes it possible for a few excellent libraries to give wide service. But the West is characterized by comparatively few large centers, separated by great distances. Scientific investigators in those cities are too remote from New York or Chicago to avail themselves quickly of the facilities offered, and they work at a consequent disadvantage.

The technical library is the first aid to industrial research. Investigation of a problem begins with a search of the literature in order to take advantage of past experience and knowledge, and this cannot be done with any degree of satisfaction unless a fairly complete library is available. Every large city in the Rocky Mountain and Pacific Coast region should have a well selected list of technical books and magazines specially suited to the industries already established there or likely to develop. San Francisco, we believe, has an advantage over some of the other cities in her Mechanics Institute library—an advantage which Los Angeles in her new pride as the largest city on the Coast should not allow to stand. Nor should the growing cities of the Northwest lag behind in this service to their technical men. It is a matter which local sections of the national scientific and engineering societies might well promote and support.

Efficient Use Of Railroad Equipment

WITH the closer interest that the public has been forced to take in railroad affairs on account of the freight moving difficulties of the past few months there has come a partial understanding of the real difficulties in the railroad situation, where previously there had been no understanding at all. Whether there had been an organized publicity campaign or not, the public had come to think that what the railroads needed was to buy more rails, cars and locomotives than available funds permitted. The public realizes now, what it could have realized earlier if the effort had been made, that the first requisite in railroading is to obtain maximum efficiency.

Cases have been cited without number of loaded freight cars being long periods in transit, nearly six months in some cases for a journey across the continent. These loaded cars were not held up by rails lacking in track or by roughness such as some highways offer to the progress of an automobile. The difficulties have been slow handling of the cars, particularly in classification yards and at junction points. If there were more cars, the congestion would simply be greater. If more men were engaged in laying rails the extra men would be withdrawn from work that might expedite the movement of freight.

While many things are needed for the future, at the present time the chief desideratum is greater efficiency in the utilization of existing physical equipment. It is a matter of men, the number of men and their efficiency. The railroads need more men, and they need more intelligent and efficient work on the part of all the men in employ, from the lowest group to the highest. The percentages in each group of men who are not doing their best work are not known, but it is a not uncommon view among those who have had excellent opportunities to observe that inefficiency does not stop at any group, but extends clear up to the highest circles.

It would be absurd to assume that in railroading men are not actuated more or less by self interest. It is the case with all other forms of human endeavor and there is no reason to suppose that railroading is totally different in this respect. Accordingly there are three events, set for the next sixty days, that promise very considerable measures of relief from the present inefficiency. The dates for these three events are: (1) July 20, when the Railroad Labor Board is expected to make its award, setting railroad wages on a competitive basis with those paid in the industries, and putting the men in a good humor, particularly on account of the increases awarded being retroactive to May 1; (2) August 1, when the Interstate Commerce Commission is expected to announce its decision in the freight rate cases whereby, whether the railroad managements are satisfied or not, they will be given all they can hope to secure at this time; (3) September 1, when the Government guarantee of railway earnings will cease and the railroads will be thrown upon their own resources and will have to make their money themselves.

The real experiment will then begin to determine what freight and passenger service can be gotten out of the present physical equipment by efficient use of the facilities. It is certain that there will be a very material improvement over present conditions. It will then be possible to determine, as it is not at present, where and in what manner the physical equipment should be improved. More terminal facilities, more second track, more automatic signaling, more cars and more locomotives are needed, but the proportions are not determined. In some cases additional automatic signaling will be more effective than additional cars or locomotives, while in other cases the latter will be found to be the desideratum, and thus as to all details of the problem that will then be presented, but the immediate need is better employment of existing physical facilities through more efficient functioning of the human element.

Fix the Mud-Hole

A NUMBER of prosperous farmers were compelled to haul all their produce to town over a road that in most places was in fair condition but in some parts was rendered almost impassable by deep mud-holes. In order to be able to pull through these mud-holes it was necessary to use four-horse teams, although two would have been ample if these unnecessary obstacles had not existed. One day the farmers took sufficient thought to realize that what they had been doing was not only inconvenient but a source of great expense to them. So they voted an increase in their taxes sufficient to permit the road commissioners to fix the mud-holes and keep the road in repair. To their gratification, they found that not only was the expense of keeping the road in good order much less than the cost of using four horses for a two-horse job, but they were now able to use automobiles, which proved to be a great convenience and economy. So they demonstrated to themselves that one of the ways to earn money is to spend it wisely.

Much the same situation exists in industry today and it remains to be seen whether manufacturers and the general public are as intelligent as the farmers. For three years there has existed, in varying acuteness, a coal problem. Except in the brief period in the winter of 1919-20, when stocks were probably being used up and there was little demand, the mud-hole in the road of industrial progress has always been the railroads, which are unable to transport the coal that is offered. To get the coal they require, consumers bid the price up until they bring enough economic pressure to bear so they can get coal that would be freely available at the normal price if the railroads could move all the coal that the mines offer. To be specific, coal that at Hampton Roads normally costs $5.50 per ton, of which $2 is the freight charge, is now eagerly snapped up at $11 a ton and buyers cannot get nearly as much as they need. Industry is using the four-horse team of doubled prices to pull it through the mud-hole of railroad disability. It is peculiarly inefficient because the premium paid by the buyer does not go to the railroads to induce them to move more coal, but to various others who take advantage of the situation to collect "all the traffic will bear."

The remedy is simple and obvious: increase the freight rate on coal. The increased earnings of the railroads will then enable them to purchase equipment and pay wages high enough to retain their men in competition with industry. An increase in freight rates sufficient to average $1 per ton on all the coal mined would give the railroads nearly $700,000,000 increase in annual earnings and would cost the public less than it is now paying to get coal across the morass of the railroads' inability to handle it.

Readers' Views and Comments

Copper and Magnetite in Copper Smelter Slags

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article, "Copper and Magnetite in Copper Smelter Slags," by Maier and Van Arsdale, CHEM. & MET. ENGINEERING, June 16 and June 23, is most interesting and is an excellent illustration of the valuable assistance which the metallurgist of today may obtain from skilled research investigation.

In considering this article the writer's thoughts go back to the 80's, in Colorado, when American lead-smelting practice was so largely being developed, and the metallurgist of those days was encountering difficulties which it now seems may have been due to such reactions taking place in the flowing furnace slag, and which became manifest upon the advent of the first small amounts of sulphides in the ores. These difficulties had not appeared in the smelting of wholly oxidized ores, which had previously constituted the furnace charge.

It was at a time when those who were the leaders in the metallurgical thought of the day, basing their opinion upon their earlier experience with the Nevada carbonate ores, were led to place practically their entire emphasis upon exact slag composition, even to the extent of asserting the attainment of chemical types as being the necessary requisite to obtain clean slags.

To one familiar with the method of slag analysis upon which the dictum of exact slag types was based, the methods discussed in this article offer an interesting comparison.

Even in those earlier days, however, there was a group of younger metallurgists who already had an appreciation of the fact of physical mixtures within the flowing slag, and realized that the chemical analysis should, to some extent at least, be questioned, as an indication of the form of the oxides present.

Iles, for example, in his paper written for "Mineral Resources of the United States," (See *E. & M. J.* Vol. 41, March 6, 1886, Page 169) expresses the opinion that nine-tenths of slag analyses were wrong.

In this same paper Iles refers to the magnetic properties of lead-furnace slags, stating that in December, 1879, it was discovered that the slags at the works of the old Grant Smelting Co. were all magnetic, and mentions an examination having been made of 108 samples of slag in an attempt to discover the "relation between intensity of magnetism and lead and silver losses." He states also that the slags produced in all of the prominent smelting works of the country show more or less magnetic property.

There is no suggestion, however, as to possible chemical reaction between the higher oxides of iron and the matte, such as that discussed by Maier and Van Arsdale. Iles indicates that there was in some way considered to be a relation between magnetic properties and losses. This is also shown by the proposal of Neill to subject pots containing molten slag to the action of a powerful magnetic field. (*Trans.* A. I. M. E. Vol. XXII, page 675).

A most convincing demonstration, in those earlier days, that mechanical suspension of matte was largely accountable for values contained in slags, and that such values could be mechanically removed, was that afforded by the experiment, carried out upon an operating scale, at the Omaha & Grant smelting works, in Denver, some time in the 80's, with a Peck centrifugal machine. The assay results clearly demonstrated that slags could be effectively cleaned by mechanically throwing out the suspended sulphides, but the operating difficulties involved in maintaining the necessarily high speed of rotation of the separating thimble, while at the same time pouring molten slag through the machine proved insurmountable. Thus through mechanical failure an important metallurgical fact was very largely lost sight of, although, with some of us, it had the effect of hastening the lead-furnace fore-hearth and reverberatory re-treatment of blast-furnace slags.

Although such reaction as is referred to by Maier and Van Arsdale, with the resulting "flotation" of matte prills, was not at all suspected, it was generally accepted as a fact that magnetite ores were unsuitable for lead-furnace smelting in that the iron content of such ores was carried into the slag without performing its share in the slag formation from silica. This was one of our problems in Mexico, in localities where magnetite was accessible and other iron ores not so attainable. It was known that the magnetite was not reduced in the furnace, and that we paid for iron "units" for which we did not get fluxing equivalent which was the real cause of their rejection.

These very interesting investigations of Maier and Van Arsdale clearly show that metallurgists should give careful consideration to the conditions indicated, not only in the smelting of converter slag, but where a similar suspension is likely to occur in slags flowing through blast furnace fore-hearths when ores having such higher oxides constitute, to any considerable extent, the blast-furnace charge.

R. C. CANBY.

Wallingford, Conn.

Nitrogen Fixation by the Haber Method

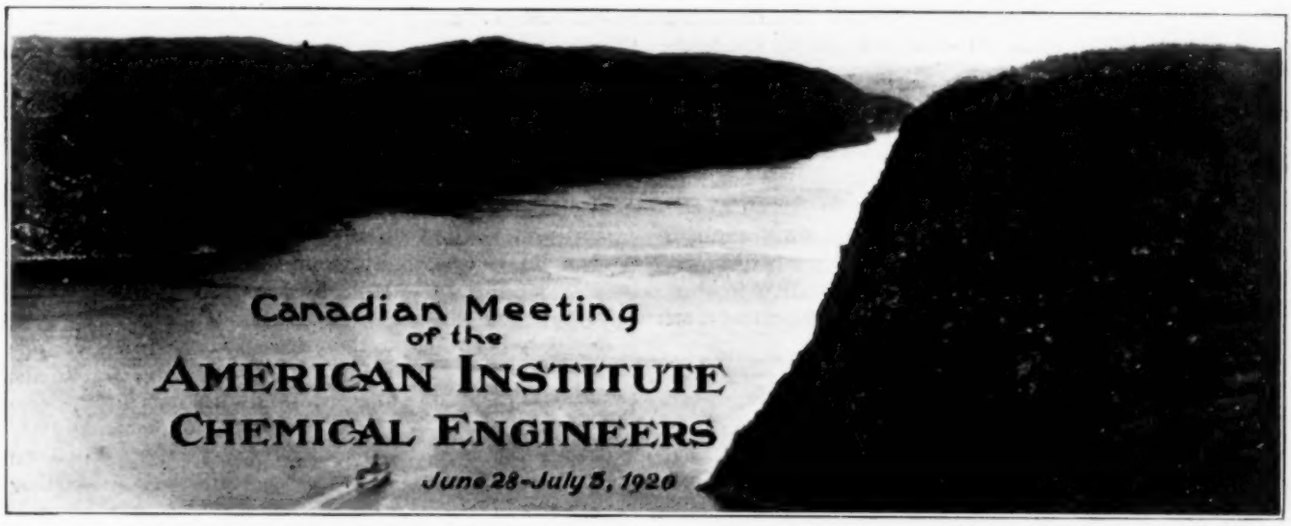
To the Editor of Chemical & Metallurgical Engineering:

SIR:—With reference to the article on the Haber process by Chester H. Jones in the June 9 number of CHEMICAL & METALLURGICAL ENGINEERING, a statement is made that one of the disadvantages of the Haber process is the "high royalty that would be demanded if the Government were to install and operate; and the inability to come to terms with the Badische company as to the use of its patents is reported to be the sole reason for the non-adoption of the method by two large American corporations," etc. A further disadvantage is, "Patents and processes controlled in America by one corporation."

It is true that the patents are owned by one corporation—The Chemical Foundation, Inc.; but we wish to take this opportunity to state that these patents are available to any qualified chemical manufacturer in this country at such a royalty as will not prove an obstacle to successful exploitation.

THE CHEMICAL FOUNDATION, INC.,

New York City. S. A. TUCKER, Chemist.



Report of the Twelfth Semi-Annual Meeting Held at Montreal and of the Visits to the Leading Canadian Chemical Plants in the Vicinity of Montreal, Ottawa, Belleville, Shawinigan Falls and La Tuque

THE Canadian members of the American Institute of Chemical Engineers and their compatriot friends made the visit of the society to the Dominion from June 26 to July 5 an extremely pleasant one. The meeting as started in Montreal had few omens of the success that was coming, for the hall supplied by the Hotel Windsor was acoustically possessed by the carpenters' union, which was diligently turning adjacent large rooms into little ones to enable the hotel to house the great convention throngs to which every train from the States was constantly adding new recruits. The Engineers' Institute of Canada rescued the paper program by having the society move over to its commodius clubhouse.

The reports of council, officers and committees were received. The meeting committee reported that New Orleans and Detroit had invited the society and it was tentatively decided to hold the December meeting at the former city and the June meeting at the latter.

Mr. Ross welcomed the society to the Dominion and spoke on the functions of the chemical engineer as being very old and in continuity with the work of all other engineers.

What Is a Chemical Engineer?

President David Wesson spoke as follows on questions involving membership in the society:

"On occasions like this precedent seems to have decreed that your president should make some kind of an address. Personally it has been a matter of debate in my mind whether an address or a sermon was the better sedative.

"If it were proper for me to deliver a sermon, I would take for my text 2d Corinthians, 3d chapter, the last part of the 6th verse, which reads as follows: 'Not of the letter of the law, but of the spirit, for the letter killeth, but the spirit giveth life.' The reason for choosing this text was brought to my mind when discussing the proposed amendment, which has brought more or less discussion among our members, and not having received the necessary two-thirds vote of the members, has failed to pass. I am free to admit that there seemed to have been a good reason for the amendment when it was first proposed, but after going into the matter fully with the chairman of our membership committee, I have concluded the amendment is unnecessary.

Work of the Membership Committee

"Those who have not served on the membership committee cannot fully realize its importance, and the great care its members take to do justice to all applicants and at the same time to see that the high standards of our membership are maintained. I have served on a jury and I have served on the membership committee, and between the two would choose the latter if I desired to obtain a thorough impartial sifting of evidence.

"No name is allowed to go on a ballot without a careful consideration by the committee of a man's qualifications and references. The greatest attention is paid to the applicant's character and ethics. Many cases come up where there is no question about the worth of a candidate and little time is lost in putting his name on the ballot. Other cases come up where the applicant obviously wants to use the Institute for selfish or advertising purposes, or is fully unqualified, and it takes no time to turn him down.

"The Institute owes its high standing to its membership committee, probably more than any other factor. It is an honor to be elected to the Institute and the membership committee tries to make it its business to see that applicants for membership will likewise add to its luster if elected.

Quality Desired Rather Than Quantity

"The Institute, as you know, was started in 1908—just twelve years ago. Our membership at present is about 400. Up to six months ago our growth was about 24 members a year. During the past six months we have added 40 or 50 members. It seems desirable that we should increase our membership to about 600, which would be nearly double what it was a year ago. We must bear in mind, however, that quality of membership is to be desired rather than quantity, and we must not lose sight of the fact that it is possible to have a society so large that it will defeat the object of sociability among its members and make delightful excursions such as we have had in the past and such as the present one impossible from mere weight of members.

It should be our object, therefore, in the future to try to secure for members those who will add to the prestige of the Institute.

Leaders of All Branches of Chemical Industry

"In the selection of new members, we should be governed by the text already quoted. There has been in the past more or less adverse criticism because the membership rules were sometimes too narrowly applied. It was some such feeling which probably started the proposed amendment which has just been rejected. I think the whole trouble has arisen from a misconception of what constitutes a chemical engineer.

"The Century Dictionary of 1909 says: 'Chemical Engineer—a degree given to graduates of a technical or engineering school for special knowledge of the scientific laws and rules of practice concerned with the manufacture of chemical products.' It is evident that if many of us applied this definition to ourselves we would find we had never taken the degree, although we were admitted to the Institute without it.

"The 1900 edition does not mention chemical engineers at all but gives as a third meaning of the word 'engineer,' 'One who carries through any scheme or enterprise by skill or artful contrivance—a manager.' The chemical engineer, therefore, is in the broadest sense of the word a chemical manager, that is, one who manages enterprises requiring the knowledge and application of chemistry. In a broad sense the head executive of a successful chemical enterprise, although not a trained chemist, might be a better chemical engineer than some man in his works who though holding the degree of chemical engineer would never rise above the position of foreman or superintendent of some small department.

"Again, the editor of a chemical engineering journal, though not practicing chemical engineering, so called, in its narrow sense, at the time of his application should, if possessed of the proper education and experience, be eligible to membership. The same rule would apply to a chemist who had turned his attention to patent law and was rendering great service to applied chemistry in securing patent protection to the industries.

"In conclusion I want to say that it is believed that the Institute should have in its membership the leaders of all branches of chemical industry; we should not wait for them to apply for membership, but should go after them. We need them and they need the Institute. The old theory that we should wait for men to apply is exploded. Naturally, many of those who apply are undesirables. We have it in our power to help the Institute by selecting the right sort of applicants ourselves and inducing them to join."

Views Presented in Discussion

In the discussion that followed Mr. Moore stated that the society was large enough and that increased membership would make it very difficult to obtain desirable plant visiting privileges. Dr. Olsen stated that there was some question as to the desirable number of members and estimated that there were only about 600 qualified men. Mr. Langmuir spoke of the difficulties encountered in connection with the large American Chemical Society meetings. Mr. Chute recommended that no limitations be set and that the society carefully select its candidates. Mr. Howard favored taking in all the able chemical engineers so as to make the Institute representative of the profession.

Prof. A. W. Smith reported for the committee on education and criticised the Mann report. He also gave a summary of Dr. W. J. Hale's recommendations on means by which industry can give support to the university staff by giving financial reward for the best publications on original investigations.

Symposium on Electrolytic Cells

Charles B. Barton opened the program with personal reminiscences of the pioneer work done at Rumford Falls, Me., in 1894-98 by LeSueur, MacDonald and Mercer.

Hugh Kelsea Moore then discussed the fundamentals of the diaphragm cell, confining himself especially to the factors controlling current and decomposition efficiencies.

Albert H. Hooker made a notable contribution on cathode brine liquors, giving the equilibriums existing between NaOH and NaCl, from which considerable guidance is obtained in getting most economical caustic production.

L. D. Vorce's paper was then introduced, in which the space factors were especially dwelt upon, and the advantages of the cylindrical cell pointed out in this regard.

Time was not available for any generalizations on cell economics, but the three variable factors of heat of evaporization, current and space were brought out individually in an exceptionally competent manner. It is planned to publish the details of the symposium at an early date.

Chemical Lime Burning

Richard K. Meade gave an interesting account of lime burning technology, describing all types of kilns and ways of heating. The latest feature presented was the use of the kiln gases in tube boilers for the production of steam. Part of this steam was used in producing water gas, which is exceptionally efficient in lime burning because the heat of both the regenerating blast and the gas is utilized. The main factors of labor, fuel and equipment costs were taken up briefly for a few cases. An account of reburning spent sludges was given at the conclusion.

Research on Evaporators

W. L. Badger gave the initial contributions resulting from the work of the evaporator experiment station at the University of Michigan. In his first paper on the effect of temperature drop and level on heat transmission in vertical tube evaporators, it was shown that the coefficient of heat transmission was a function of several variables. It decreases with temperature drop and approaches zero for zero temperature drop. It increases with boiling point for a given temperature drop. When corrected for hydrostatic head it varies directly with temperature drop. As the liquor level is increased above the top tube sheet, the heat transmission falls off along a straight line. This change is only partially due to the effect of hydrostatic head. Changes in velocity or circulation are a very important factor.

The vapor pressures of salt solutions with varying concentrations and temperatures were given. An excellent bibliography on the subject was included also.

Corrosion of Iron and Steel

W. D. Richardson presented a voluminous paper entitled "Experiments on the Corrosion of Iron and

Steel," giving the results of many years' work on corrosion of several kinds of iron and steel in water and brine. A second paper on "Rates of Solution of Iron and Steel in Non-Oxidizing Acids" studied the action of H_2SO_4, HNO_3 and HCl on the same metal.

There is a certain resemblance between the corrosion which takes place when plates are submerged in water and brine when a minimum quantity of atmospheric oxygen is present and that which occurs when metals dissolve in the ordinary non-oxidizing acids such as sulphuric and hydrochloric. This resemblance, however, while characteristic in a general way, may not hold good at all points because of one essential difference in the two conditions compared. In water and brine respectively, at rest, there is always present a small amount of oxygen to influence the course of corrosion, whereas when the samples are submerged in a non-oxidizing acid, the latter is quickly relieved of its dissolved oxygen and henceforward the only gas present in solution is hydrogen resulting from the action of the metal on the acid and perhaps small quantities of other gases arising from impurities in the metal.

Relatively pure iron dissolves at a low rate in non-oxidizing acids. Less pure metals, such as cast iron, white cast iron and malleable irons, dissolve in H_2SO_4 at a relatively high rate, while cast steel dissolves at a rate between the two. On the other hand, in normal nitric acid, the relatively pure metals dissolve at a very high rate while the less pure metals, such as cast iron, white cast iron, malleable iron and semi-steel, dissolve at a much lower rate, and cast steel again occupies a position between the two extremes.

With these experimental figures at hand, Mr. RICHARDSON in a third paper presents a "Suggested Basis for an Index of Corrosion for Iron and Steel." His recommendation is to prepare a piece of 16-g. material 6 in. (15 cm.) square, by sanding each surface free of mill scale, then immersing one piece each in normal HNO_3 and H_2SO_4 at 16 deg. C. After immersion for one hour, they are carefully cleaned with a stiff bristle brush, dried, and the loss determined. The index of corrosion then is expressed by the ratio of loss per sq.cm. per hr. in HNO_3 to that in H_2SO_4. It should not be thought that the figures represent absolute ratios. Much more data would have to be accumulated and interpreted before any precise conclusions could be drawn, but since the rate of solution in non-oxidizing normal acid compared with the rate in normal oxidizing acid appears to run parallel to the rates of corrosion when an abundant supply of oxygen is present and when a limited supply is present respectively, it is thought that a rational opinion of the corrodibility of a given kind of metal can be formed from its behavior in the two acids.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, HOTEL WINDSOR, MONTREAL, CANADA

1. A. C. Langmuir
2. Richard K. Meade
4. Hugh K. Moore
5. J. R. M. Klotz
6. J. T. Baker
7. W. C. Bainbridge
8. Mrs. C. Sundstrom
9. P. F. McCleary
10. E. W. Wiggins
11. Mrs. A. B. Conner
12. Edgar Stansfield
13. J. F. Clark Carnell
14. J. V. N. Dorr
15. W. B. Campbell
16. Mrs. W. B. Carnell
17. W. C. Carnell
18. W. R. Clymer
19. Mrs. Ethel Takamine
20. G. H. Dorr
21. Earl Durfee
22. Jokichi Takamine
23. A. D. Chambers
24. E. W. Tucker
25. Mrs. E. Durfee
26. Benjamin T. Brooks
27. Clarke E. Davis
28. N. C. Ortved
29. Mrs. C. B. Clark
30. Arthur Wright
31. Parker C. McIlhiney
32. C. R. Bellamy
33. John C. Olsen, Secy.
34. Mrs. David Wesson
35. David Wesson, Pres.
36. Ralph H. McKee
37. Mrs. Benjamin T. Brooks
38. Mr. Bellamy, Sr.
39. E. C. Holton
40. D. H. Litter
41. Clarence W. Marsh
42. P. C. Kingsbury
43. C. B. Clark
44. B. R. Tunison
45. John B. Howard
46. Mrs. Henry Howard
47. Henry Howard
48. H. O. Chute
49. Mrs. J. H. Dunbar
50. Thomas C. Howard
51. J. H. Dunbar
52. Mrs. A. W. Smith
53. Charles S. Hollander
54. D. S. McAfee
55. A. W. Smith
56. Mrs. A. D. Chambers
57. W. L. Badger
58. A. E. Marshall
59. Joseph W. Richards
60. V. C. Edwards
61. S. L. Tyler
62. Mrs. G. M. Davidson
63. G. M. Davidson
64. R. S. Sherwin
65. Mrs. A. A. Bartow
66. A. Guillaudeu
67. E. B. Miller
68. J. D. Kerr
69. A. C. Houghton
70. S. F. Grove
71. Mrs. Beck
72. H. H. Meyers
73. W. H. Gesell
74. Mrs. A. M. Comey
75. A. M. Comey
76. Walter Laib
77. F. H. Garner
78. C. C. Ahlum
79. L. D. Simpkins
80. Mrs. A. H. Hooker
81. Louis J. Matos
82. W. W. Rhodes
83. F. C. Zeisberg
84. Mrs. W. C. Bainbridge
85. Samuel P. Sadtler
86. T. L. Lyster
87. Edward Bartow
88. Miss A. Seeker
89. Harlan S. Miner
90. Joseph Maudru
91. G. P. Hahlweg
92. Mrs. W. H. Gesell
93. E. F. Buchanan
94. R. W. Shafler
95. Mrs. G. A. Prochazka
96. S. P. Miller
97. C. A. Peterson
98. Miss Prochazka
99. George A. Richter
100. R. S. Weston
101. Mrs. Sherley P. Newton
102. J. S. Dean
103. James Morrison
104. Floyd F. White
105. Mrs. C. B. Morey
106. C. M. E. Schroeder
107. Robert W. Savidge
108. Mrs. W. L. Spalding
109. W. A. Hicks
110. Price Green
112. Sherley P. Newton
113. J. W. Rawlins
114. W. L. Spalding
115. H. E. Batsford
116. H. Rollins
117. W. L. Spalding
118. A. B. Conner
119. C. B. Morey
120. Henry Hess
121. Carl Sundstrom

TOUR AND EXCURSIONS

Tuesday afternoon was devoted to visiting the plant of Marx & Rawolle, where a crude sweet liquor is distilled producing dynamite, commercial and chemically pure glycerine. Two shifts of six men each operate the works, producing about 3,000,000 lb. of glycerine

per year. F. J. Wood designed the large multiple effect units, which are continuously charged with superheated concentrated sweet liquor.

A special train was provided by the Canadian National Railway containing five Pullmans with dining and baggage cars for the three-day tour. The beautiful capital city, Ottawa, was the first point of interest. Here the local members of the Society of Chemical Industry had provided an elaborate program. Luncheon was served, after which SIR GEORGE FOSTER, acting Premier, gave an after-dinner speech, which pointed out the great fuel problem confronting Canada. A small box containing a lignite briquet was set at each plate, that the society might have a souvenir of the occasion.

A quick tour was made over to Hull through the local pulp and lumber industry. The old Eddy mill was of exceptional historical interest, as it was operating with horizontal digesters on 24-hr. shifts, just as was the practice in 1889. After the industrial excursion, the entire party was taken around Lady Grey Drive in automobiles, where they obtained fine views of the lively Ottawa River and the stately edifices which house the various governmental departments.

BELLEVILLE ACTIVITIES

The Institute special train pulled into Belleville just before midnight, but the town was not asleep. A full military band gave evidence to this effect and after a few commands from Captain Lucius E. Allen an excellent parade and street dance were staged.

In the morning cars were at hand for the tour through the picturesque roads of Hastings County. Deloro was reached at noon, luncheon was served, more speeches were heard, and the plant of the Deloro Smelting & Refining Co. was visited. Here the high cobalt ore concentrates are roasted to sublime the antimony, salted and heated to convert the silver salts to cyanide soluble forms, the residue of which is then dissolved in sulphuric acid. Fractional precipitation of pure cobaltic hydroxide, with the nickelic coming down with higher hydroxyl concentration, was obtained by the use of sodium hypochlorite. The cobalt hydroxide is heated to form the various oxides used in ceramics, or dissolved in acids to obtain various salts, or reduced to metal. A large amount of stellite is being produced at the plant for the Haynes company at Kokomo, Ind. The silver is removed by adding aluminum powder to the cyanide, filtering, and smelting. The antimony is resublimed and ground.

On the return trip to Belleville, the large talc grinding plant of S. H. Gillespie was visited. Then the plant of the Industrial Alcohol Co. at Corbyville was passed through. This company produces beverage alcohol about one-sixth of the time. The fermenting vats were open, but it is planned to remove the alcohol vapor from the CO_2 gas emission.

INSTITUTE MEDAL AWARDED

Upon returning from the hundred mile tour, the party was agreeably surprised to find a banquet awaiting them at the Quinte. Captain ALLEN made a very excellent toastmaster and Colonel R. D. PONTON proved to be as able in commanding words as men. Dr. S. P. SADTLER gave added dignity to the occasion by reciting the extraordinary accomplishments of H. K. MOORE, whom the Institute chose to honor with its medal, because he had devoted unselfishly a liberal part of his time in writing scholarly papers of the greatest benefit to his fellow engineers.

VISIT TO SHAWINIGAN FALLS PLANT

The Canada Carbide plant gave the visitors an excellent opportunity for seeing a three-phase carbide furnace in operation. The molten reduction product of burned lime and coke was drawn off at intervals in cast iron cars, where it cooled before being carried to the crushers. A large part of the carbide was packed in metal drums for shipment.

The electrode department was passed through enroute to the acetylene products plant. Coke was pulverized and bonded with hard pitch. The 16-in. electrodes were extruded and the volatile hydrocarbons removed by heating in kilns. Space will not be taken here for giving details on the acetic-acid-from-acetylene process, which was next inspected, as it has been recently described in this journal[1].

Buffet supper was served at the Cascade Inn. The piano was tuned up and everybody sang. Dancing was soon in order and the party did not break up until the conductor called "all aboard."

LA TUQUE MILLS AND SORTING GAP

Morning found the train sidetracked in front of the Brown Co.'s sulphate pulp plant at La Tuque. Here an opportunity was given to see digesters using the Morterude system of heating liquor, the spray process for burning the concentrated black liquors so as to recover their caustic content, a Cottrell precipitator and a new counter-current perforated drum pulp washing machine, in addition to all the usual equipment that constitutes a strictly modern pulp plant. The electric precipitator was being rebuilt at the time, as a large part of the soda vapors had not been caught by the first installation due to insufficient cooling and other causes.

The sorting gap on the St. Maurice River was exceedingly interesting, for SIMMONS BROWN had the camp cook prepare a Canadian lumberjack dinner, which was followed by an entertainment. The log rolling contest might have been enjoyed more if some of the chemical engineers had joined in and no doubt they would have done so, had they known the little joke Jupiter Pluvius had in store. None of them got back dry but they all seemed to be happy and put lots of force into "Alouette, je te plumerai la tête, le bec, le nez, le dos, les pattes, le cou, etc.

SAGUENAY RIVER

The meeting closed amid the beautiful Laurentine mountains on the Saguenay river, the greatest of mountain streams. The grandeur of Cape Eternity towering almost one-third of a mile into the sky can not be described by words. It has been left to the art of photography to convey an impression of it in our heading.

Monday and Tuesday were spent sightseeing in the historical city of Quebec. The shrine of Sainte Anne de Beaupré was the most interesting of the churches, standing out from 1658 until the present as a center of intense religious activity of the old school. About 200,000 pilgrims flock to it annually owing to the supernatural curative influences with which it is believed by them to be endowed.

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[1] "Synthetic Acetic Acid and Acetone," J. T. Rooney, CHEM. AND MET. ENG., vol. 22, p. 847; May 5, 1920.

The Future of Oxygen Enrichment of Air in Metallurgical Operations*

Apparent Possibilities of Applying Cheap Oxygen to Various Standardized Metallurgical Operations, Permitting Closer Economy of Blast Furnace Fuel, Reducing Atmospheres in the Open-Hearth, and Low-Silicon Iron to Converters

BY F. G. COTTRELL

ALTHOUGH oxygen is the commonest of all the chemical elements, making up nearly one-half of that portion of our globe which we have yet penetrated and is found in a perfectly free, that is, chemically uncombined state in the air, simply mixed with about four times its volume of inert nitrogen and very small amounts of other gases, still it has never yet been separated and used in any concentration above that of the atmosphere on a scale at all commensurate with its importance and industrial possibilities.

Not only is it the most common of all the elements, but it enters actively into more processes absolutely vital to human life and industry and to a far greater total tonnage than any other element. We have known of it and its striking properties ever since Priestley first prepared pure oxygen in 1774 and it has ever since been a potent reagent in the hands of the chemist for the special purposes of his laboratory. Still it has taken over a hundred years to bring it forward as a general industrial tool even to the comparatively limited extent it has already reached, while many other elements vastly rarer, inherently more difficult to extract and far less important in their practical applications, have outstripped it in the race.

This situation, in fact, presents almost an unique anomaly in our technical and economic development and can only be compared to those which ushered in the industrial application of the steam engine and later that of the electric dynamo and motor.

PROBLEM REQUIRES LARGE-SCALE TECHNICAL AND SCIENTIFIC CO-OPERATION

The reason that the possibilities and importance of very large scale applications of concentrated oxygen have not heretofore been fully appreciated and developed probably lies in the very magnitude of the project and the diversity of both technical and economic elements involved, rather than in any special difficulty inherent in any one of these individually. In other words, what is most fundamentally needed is the broad comprehensive grasp of the interrelation of these parts of the problem to one another and the ability to find, bring together and hold in active effective co-operation the specialists who can successfully deliver each element of the undertaking, be it technical, administrative or financial.

Turning to the history of commercial oxygen production we find the early industry based generally upon the decomposition of potassium chlorate by heat and the chief market for the gas in the oxyhydrogen or lime light for stereopticon and spectacular purposes with a smaller though important field for medical use. This process of manufacture held the field for practical purposes for many years. Later came the Brinn process substituting barium dioxide for the potassium chlorate and having the significant novel feature of regeneration of the residue of barium monoxide back again to barium dioxide by recombination of oxygen from the air through a change of either pressure or temperature, thus amounting on the whole to the use of barium compounds merely as a carrier to effect the fairly direct separation of oxygen from the air.

The Brinn process came very early, however, into active competition with the production of oxygen by the electrolysis of water, the growth of this latter from about 1895 being a natural consequence of the rapid general development and introduction of electric power into industry in general.

Since in the electrolytic process the determining factor of cost is the power consumption and it was relatively easy from the first to closely approximate in practice the theoretical efficiency possible by this process, the cost of oxygen soon became standardized to the cost of power on the open market and became almost as stable as that of power itself. Furthermore, electrolytic cells were relatively easy to build and operate in units of any size and there were no truly fundamental patents to affect the situation.

The last and most important innovation was the commercial development by Carl Linde, of Munich, and later by Georges Claude, of Paris, of air separation through liquefaction and distillation.

This it was that first vividly opened up to those in position to appreciate it the real vision of the ultimate possibilities for really cheap oxygen. It did not and has not to date, however, brought any significant lowering of the price of oxygen to the ultimate consumer and this is still practically determined as far as this country is concerned by the cost of production of the 25 per cent of our present supply still manufactured through the electrolytic process, plus the cost of bottling, freight on steel cylinders and overhead of the sales and administrative machinery required in such a business.

VIEW OF THE PRESENT OXYGEN INDUSTRY

Speaking in round figures, merely to give a birdseye view of the present oxygen industry in relation to what expansion and changes application to major metallurgical operations would mean, the United States' present production is about 3,000,000 cu.ft., or say, 130 tons, of oxygen per day, over 95 per cent of which is probably used in torches for cutting and welding purposes.

The one-quarter of this produced by electrolysis comes from several hundred privately owned plants, many of them quite small, and producing gas only for their

*Paper presented at the meeting of Iron and Steel Institute, New York, May 28, 1920.

owners' uses. The remaining three-fourths of the supply comes from about 50 air liquefaction plants owned and operated by the Linde Air Products Co., using the Linde process, and the Air Reduction Co., using, for the most part, the Claude process, but with still some production from the old Hildebrand process. The first of these two companies is the older and has somewhat the larger production. Practically the whole product from both companies is compressed into steel cylinders and sold to the trade.

The largest single installation for air separation ever erected was in connection with the cyanamide nitrogen fixation plant built for the Government at Muscle Shoals, Alabama, during the war. This consists of thirty of the largest size of Claude units. It was built primarily to secure nitrogen but if operated at full capacity for oxygen would be just about equal in output to this country's total production as given above, and this in turn is just about equal to ½ of the amount of oxygen contained in the air blown to one full sized iron blast furnace making approximately 500 tons of iron per day. The United States' average daily production of iron last year was equivalent to that of about 170 such furnaces running every day in the year.

Horsepower Required to Separate Oxygen From Water and From Air

Computed directly from its heat of formation water should theoretically be decomposable with a voltage of 1.48 and a current consumption of 3,032,000 amp. hr. per ton of oxygen; or in round numbers about 6,000 hp. hr., which even at 0.2. per hp. hr. would be $12 per ton of oxygen produced. This represents the energy of chemical combination of the oxygen with the hydrogen in the formation of water and must be supplied from without in the decomposition of the latter.

In the separation of air, on the other hand, there is no chemical combination to overcome. The oxygen and nitrogen simply dilute one another in a simple mixture of the two, and theoretically require no energy expenditure for their mere separation. Due to their mutual dilution, however, their partial pressures in the mixture are only ⅕ atmosphere for the oxygen, and ⅘ atmosphere for the nitrogen and as when finally separated they must both have been compressed up to one atmosphere, we must do at least this much work upon them which amounts, under assumption of isothermal compression to be about 60 hp. hr. per ton of oxygen produced, or only about 1 per cent of that theoretically required by the electrolytic process for producing the same quantity of oxygen, the byproducts being in the one case 3½ tons of nitrogen and in the other ⅛ ton of hydrogen. The values above given are, of course, the purely theoretical limits based on 100 per cent efficiency for every step of the process and piece of the apparatus employed and apply equally to any "reversible" process irrespective of whether it depends upon mechanical, physical or chemical steps. Thus, whether we try to centrifuge the gases apart, or liquefy and distill them, or dissolve them in water under pressure and re-liberate them in fractionated form from solution, or even combine the oxygen with barium oxide and re-liberate it, as in the old Brinn process, the theoretical limiting power requirements are the same and all that interests us from the power standpoint in any cyclic process is the measure in practice of its divergence from reversibility. The criteria of selection among these alternative processes from the side of power consumption must, therefore, be based upon losses of reversibility, i.e., on friction, mechanical leakage, leakage of heat, chemical inertia and losses of thermodynamic potential generally. In practice today the electrolytic process actually reaches an efficiency of from 80 to 85 per cent and probably only very small additional gains on this can be looked for without running up fixed charges proportionally.

Of all the proposed air separation processes, that of air liquefaction and distillation seems not only to have already outstripped all others in the race but to present naturally the most attractive features for large scale development.

Centrifugal Separation of Oxygen From Air

Under very high centrifugal force there is an appreciable tendency for air to stratify into layers of increasing oxygen content toward the periphery of the rotating mass, but the effect is rather small for the magnitude of centrifugal force we can expect to reach safely on a large scale with the strength of materials of construction now available. If we think of this as a continuous process with the air steadily flowing through the apparatus, very special precautions would apparently be necessary to prevent the current from disturbing the process of stratification, as there would be no sharp boundary between layers of different composition as there is between liquid and gas in the liquefaction process. There have been numerous patents taken out on the centrifugal separation of gases, but none of them as yet published seems to meet in comprehensive detail many of these fundamental difficulties, though one would be rash indeed to predict that human ingenuity may not yet produce something of practical value in this field. However oxygen and nitrogen, with a ratio of densities of only 7 to 8, present one of the most unfavorable pairs of gases which could be selected to which to apply the centrifugal method so that, if it ever is worked out in practice, it is apt to find its best competitive field elsewhere, at least at the outset, say for example, in separating hydrogen from water gas where the ratio of densities is from 50 to 100 times as favorable for this method.

Solution of air in water and re-liberation by drop in pressure also effects a concentration of the oxygen, as it is more soluble than the nitrogen. If high concentrations are desired, it becomes necessary as in the case of centrifugal treatment, to repeat the process several times. The process, while simple, would require, however, either very large equipment, or the use of very high pressure, or both, when compared to direct liquefaction.

The use of a chemical absorbent like the barium oxide of the Brinn process, would be much more practical and attractive if we could find some cheap and stable substance which had much the same properties as the hæmoglobin of the blood with respect to the absorbing and liberating of oxygen without waste of energy. Up to date, however, none of the many substances which have been suggested for the purpose have proved to combine these desirable qualities in sufficiently high degree to promise serious competition with the liquefaction process.

Expected Economies in Fractional Separation

The power efficiency in commercial air separation plants already reached on the other hand has probably not much exceeded if indeed it has reached 10 per cent

of the theoretical as above given. Here, however, there is a much more hopeful outlook for improvement, as there seems no fundamental reason why we should not multiply the present efficiency several fold by applying the same sort of good intelligent engineering which has brought the steam engine to where it stands today, as the elements of the problems are fundamentally almost identical.

Even with present equipment, the power cost item in air separation is of an order of magnitude comparable with the items of fixed charges, labor and other costs, in all of which further reduction can also reasonably be expected.

In considering items of cost, and especially as concerns installation and power, it is well to bear in mind that if the oxygen plant is included as an integral part when the metallurgical works are first built, a very considerable saving may probably be made through the reduction in size or the entire elimination of other structures, such as stoves, dust catchers, gas mains and the like and that a number of power savings might likewise probably be effected, though the detailed discussion of this belongs more properly under the later head of the metallurgical applications themselves. The development of this work is strictly an engineering project dealing with the handling of large masses of material and must be approached through practice at every point as contrasted with laboratory and experimental methods.

The possible effects to be expected from oxygen enrichment of the air stream must be rather carefully distinguished under several different heads.

Effect of Oxygen on Calorific Intensity

The effect which we are most apt to think of first is simply raising the temperature. This may be beneficial and important in some cases, but most of our present metallurgical processes are already standardized to pretty definite temperatures for very good reasons and, if enrichment of air is applied to them, the chief reasons will probably be other than for a temperature change per se. In fact, many temperatures in metallurgical operations are more definitely defined by the character of the charge than is always recognized even by those most familiar with practical operation. This is particularly so in blast furnace operations for, if more heat units are supplied or less taken away the furnace simply runs faster, but the temperature of the metal, and slag, can vary only slightly, as these are nearly though not quite completely determined by the composition and consequent melting point of the charge. The temperature of the coke and gas current in the furnace, especially in its lower position, may, of course, rise very considerably and this in turn slightly superheat the metal and slag as they fall through the lower part of the furnace filled chiefly with coke.

The most important way in which enrichment of blast may essentially influence blast furnace temperatures is indirectly by allowing variations in composition of charge, e.g., making of ferrosilicon or ferrochrome directly in the blast furnace. In the case of the open-hearth, and especially the converter, the temperature question is a more pertinent one, as their operation is not controlled by the melting and automatically flowing away of their charges.

On the other hand, the distribution of heat between the hearth and shaft of the blast furnace is tremendously influenced by enrichment of the blast with oxygen because of the diminution of the total amount of gases going up the shaft per unit of carbon burned. It must be remembered that the blast furnace is of all our metallurgical equipment the most complicated from the standpoint of interrelated mechanical and chemical processes going on inside of it and has reached its present state of development by very gradual and conservative steps over a long period. It may therefore not present the most favorable unit on which to commence the regular use of enriched air for standard and continuous operations.

In fact if we ever come to use highly enriched air in making ordinary pig iron the resulting furnace is apt to have very little resemblance to the blast furnace of today. Our experience in the meantime with electric furnaces should help greatly in this evolution, as the conditions to be fulfilled in an enriched air furnace may reasonably be expected to lie between those of the electric and the present blast furnace.

Attractive Use as Standby

As the blast furnace, however, is the piece of equipment requiring the most continuous and uninterrupted operation, it may be that the enrichment of air for it as an emergency measure in case of trouble such as a threatened freeze-up may prove of considerable importance. Not that freeze-ups really happen with the frequency which one would assume from their prominence in text books and discussions, but that this very infrequency may mean that blast furnace operators have come to work with so safe a margin of conditions to avoid them, that this insurance is costing daily in coke consumption and other requirements or results very much more than we realize, and if one could have a standby source of oxygen for enrichment purposes in case of emergency, even though it were not used at all in normal operations, it might permit of safely running on a very much closer margin in the heat allowance of the furnace and making important improvements in its general economy and efficiency.

Another important effect of the enrichment of the air would be the higher calorific value of the blast furnace gas obtained as a byproduct due to elimination of part of its nitrogen. This in turn should mean cheapening of gas engine and other equipment on which it may be used. Furthermore the removal of nitrogen from the blast air would tend to eliminate the necessity for hot blast stoves which at present consume about ⅓ of the total heat value of the gas produced in the furnace.

Oxygen in Open-Hearth

The open-hearth presents some of the most interesting possibilities for the application of oxygen, particularly in those operations where the electric furnace has been the open-hearth's strongest competitor, e.g., where very high temperatures coupled with a reducing atmosphere are desired, as in the elimination of sulphur as calcium sulphide. With an open-hearth using ordinary air in order to reach the highest temperatures now attainable, a complete and carefully balanced combustion of the gases must be secured resulting in a neutral or slightly oxidizing atmosphere, whereas if part at least of the furnace's burden of inert nitrogen could be removed by the use of enriched air the same temperature could be reached while still leaving a residue of unburnt material in the gas, thus producing a strongly reducing atmosphere. By enriching the air the total

volume of gases passing through the furnace per unit of fuel burned and heat produced may be cut down enormously, since in the air there are four volumes of inert nitrogen to every volume of useful oxygen. This would greatly facilitate heat exchange and reduce mechanical difficulties such as dust losses, maintenance and control of draft and the like, or on the other hand permit of speeding up the furnace and thus increasing its daily output and correspondingly reduce fixed charges and labor per unit of product.

If we carry the application of oxygen back of the open-hearth to the gas producer we may still further extend the same principles and deliver to the furnace more thermal units per unit of primary fuel consumed; beside the actual saving of fuel which this represents, it may in some instances be still more important in cutting down the amount of impurities especially sulphur, carried into the metal from the fuel. Aside from both of these considerations and viewing the gas producer simply as an isolated unit in connection with either heating or power operations, oxygen enrichment of its air supply will permit the use of fuels which could not otherwise be burned in it at all and thus vastly increase our available fuel resources.

Converting Practice

In the matter of possible application to the converter it is perhaps hazardous to speculate in advance of actual experimentation, but once an adequate supply of oxygen is available in the steel works such experimentation will almost inevitably produce useful results, some perhaps from directions we least expect. One of the conditions limiting what metal may go to the converter is the fuel value of the metalloids it contains and in many cases we are paying rather heavily through operating conditions of the blast furnace to put silicon into iron largely for its fuel value later in the converter. A good part of these heat requirements might be removed by abstracting part of the dead load of inert nitrogen from the converting air. Whether such a procedure might lead to a change in our practical classification of bessemer ores is an interesting question, but there seems to be so much difference of opinion at present and so many factors enter into the problem that all that can here be done is to merely mention the problem as suggestive of the wide and intensely interesting field of possibilities which cheap oxygen will open up.

In the copper blast furnace running on sulphides with its relatively short shaft and hot top, the advantage of oxygen enrichment is much less open to question than in the case of the iron furnace. Furthermore in all furnace treatments of sulphide ores the problem of disposal of the sulphur in the waste gases is one of ever increasing acuteness as our mining and smelting communities with increase in surrounding settlements meet with more and more exacting conditions with regard to fume and smoke abatement. One of the difficulties in the way of the successful economic treatment of many of these gases for the removal and utilization of the objectionable constituents has been the great dilution of the latter and consequent large volume of inert gases to be handled, a situation which may have quite a bearing on the interest manifested in the problem under discussion. In this connection the use of oxygen may also prove the key to the commercial recovery of sulphur in elementary form from sulphide ores which has been a very elusive and at times a very live problem ever since John Holway's classic work on pyritic smelting in 1878. Also in the roasting of difficultly burning sulphide ores such as those of zinc and very low grade copper ores and tailings preparatory to leaching, the availability of cheap oxygen will be very important especially where the resulting gases are to be further utilized for their sulphur dioxide content either for sulphuric acid manufacture or for other purposes.

Last but perhaps not least may also be mentioned the part that oxygen may play in some of the newest developments of general metallurgy, viz., volatilization processes, where in contrast to most of the older metallurgical processes high temperatures may in themselves play an important rôle. Aside from zinc, cadmium, and mercury it is only lately that we have seriously concerned ourselves with the primary recovery of metals by volatilizing them from their ores but just as hydrometallurgy after a long and discouraging struggle finally won a foothold through the successful application of the cyanide process to gold and silver ores, so now what we might term "gas-metallurgy" seems also struggling for recognition and finding encouraging applications to lead, copper, gold, and silver, to say nothing of potash and phosphorus.

But these last two carry us off again and still further into the field of applied chemistry, where besides the very important group of carbides and nitrides there are a host of other applications for cheap industrial oxygen, even the mention of which the limitations of time and the intended scope of this paper forbid.

Light Creosote Oils in Wood Preservation*

Service records have shown that light creosote oils properly injected into wood will prevent decay until the wood wears out or checks so badly that the untreated portions are exposed.

Creosotes used in ties from twenty-five to fifty years ago were for the most part oils having 50 per cent or more distilling below 235 deg. C., with a residue not to exceed 25 per cent at 315 deg. C. The ties so treated lasted fifteen to twenty years, and failure was traceable in most cases to mechanical wear, such as rail cutting and spike killing. In no case was failure found to be the fault of preservative.

Of 1,558 telegraph poles in the Montgomery-New Orleans line, which were pressure-treated with a light creosote oil, 1,049 poles were still sound after sixteen years. In 91 per cent of the cases of decay, the fungi had entered the wood through checks and shakes. Representative sections in the Norfolk-Washington line showed that after seventeen years' service, of the 1,614 poles inspected, 1,469 were sound, 92 decayed at the top, and 105 decayed at the ground line. The decay at the top was caused chiefly by cutting off the poles. In those decayed at the ground line, the causes of failure, as determined in 88 per cent of the cases, were checks or shakes. Here again, as in the ties, the preservative outlasted the mechanical life of the wood.

Unless some other factor than protection from decay is considered important, therefore, there is apparently no need to specify high-boiling oils. The important point is that any coal-tar creosote which is not extremely low boiling or extremely high boiling will satisfactorily prevent decay, and in the selection of an oil, factors such as price, penetrability and convenience in handling should receive greater consideration than moderate differences in volatility.

*From Forest Products Laboratory *Technical Notes*, June, 1920.

Czechoslovak Glass Situation

NOTWITHSTANDING constantly increasing production, Czechoslovak glass factories are oversold for some time to come. There are dealers who have accumulated fairly good stock from whom goods can be secured, but as a rule manufacturers cannot accept orders for early delivery. New concerns have been organized with large modern plants. Four establishments have been completed and the latest machinery is being installed. These, with sixty additional enterprises are expected to increase the normal pre-war capacity by 50 per cent. The present production in the Czechoslovak glass industry, according to Engineer Josef Soukup, secretary of the Czechoslovak Glass Syndicate, can be estimated from the quantities of coal needed in the industry and the number of tons actually allotted to it. In the month of March, 1920, the entire coal demand of the glass industry was 155,418 metric tons and the allotment was 83,445 tons. April, 1920, the demand was for 160,125 tons, and the allotment was 71,138 tons.

The following is a list of what is known as the hollow and cast glass section, which is said to operate at 60 per cent of its capacity:

Sixty-six ordinary hollow-glass factories.
Nineteen cast-glass factories.
Eleven machine cast-glass factories.
Fifty-two cut-glass factories.
Twenty-four factories manufacturing lighting fixtures, globes, shades, etc.
Eleven factories manufacturing glass rods and tubes.
Nineteen factories making crude glass for the Bor (Haida) fancy glass.
Seventeen colored composition and special glass factories.
Three watch-crystal glass factories.
Three chemical glass factories.

Before the war these products in the former Austro-Hungarian Empire were valued at 137,400,000 crowns (the normal value of the crown was $0.203 U. S. currency) whereof the share of factories located in the present territory of Czechoslovakia was 120,500,000 crowns. The present monthly production amounts to 25,000 metric tons, with prospects of its reaching in the near future 35,000 tons a month. Eighty per cent thereof, comprising principally glassware for household use, cut glass, chandeliers, lamp chimneys, bulbs for incandescent lamps, watch crystals, and chemical glass, has been exported.

Window, Mirror and Photographic Glass

The window-glass industry, which comprises twenty-nine factories, twenty-four of which are manufacturing window glass, three blown-mirror glass, and two photographic glass, are operating at 75 per cent of their capacity. A 25 per cent increase in production is in view on account of the intense demand and improvement in conditions generally. Eighty-five per cent of the output is exported, since 15 per cent of the output is sufficient for domestic needs. Photographic glass is manufactured almost entirely for foreign countries. Before the war the total Austro-Hungarian production of window glass was 12,060,000 sq.m., of which 10,900,000 sq.m. was manufactured in the present territory of Czechoslovakia. Fourcault machines are mostly used. Some concerns use window-glass machines under a license from an American firm, which machines are found very satisfactory.

During the war the inability to secure copping wire from America made their operation difficult because a substitute that was tried gave poor results. Six factories which manufacture cast smooth and ribbed glass for buildings and four factories making cast mirror glass are operating at 60 per cent of their capacity. Fifty per cent of the product is exported as mirror looking glass, and 30 per cent is exported partly manufactured, leaving 20 per cent for domestic needs.

Output of Bottles

Plants making all varieties of bottles, seventeen in number, are operating at 35 per cent of their capacity. During the year 1919 they were in a position to turn out 171,000,000 bottles. Since their output was limited by the quantity of coal, soda, potash, and other raw materials needed in their production, the actual production was only about 60,000,000 pieces. In pre-war time, in the territory of what is now known as Czechoslovakia, 165,000,000 bottles were manufactured annually, while in the rest of the Austro-Hungarian Empire only 15,000,000. In Czechoslovakia 49,500,000 bottles were consumed, leaving 115,500,000 for export. The factories have recently installed several American machines, so that their productive capacity has been increased to 240,000,000 pieces.

Factories Using Coal and Wood

In all there are 156 glass factories in Czechoslovakia. The oldest are located near forests because of the wood that was needed in glass production. But with the increase in the price of wood and owing to the discovery of factory production with the use of chemicals, soda, potash, and glauber salt, the factories have been gradually giving way to those using coal exclusively of which there are now 103; fifteen factories still use wood only, and twenty-one use both wood and coal. Five of the old plants have been abandoned and four are not in operation.

The seventeen special and colored composition glass factories are small concerns.

Other Glass Enterprises

In addition to the regular glass plants there are over 3,500 independent enterprises that finish partly manufactured glass products. Besides these there are thousands of homes where practically all the members of the family do work which cannot be done by machines. This is mostly in the Gablonz industry, which employs in all about 50,000 people. Until recently the Gablonz goods exports amounted to a value of about 90,000,000 Czechoslovak crowns a month. The climax was reached about the middle of April of this year, when the effect of the rising value of the crown was noticeable. Since then exports have fallen off about one-third. The increase by the Government of the export tax on Gablonz goods from ½ per cent to 5 per cent of the invoice price has had a deterrent effect.

While soda and potash are manufactured in Czechoslovakia, great quantities must be imported from Austria and Germany. About 1,000 metric tons of potash, it is said, would cover the needs of the glass industry for one year, and domestic production thereafter would be sufficient; fifty tons of saltpeter, 1,000 tons of glauber salt, twenty tons of boric acid, 100 kilos of selenium, and 20 kilos of gold must be imported monthly for the industry; 2,000 kilos of nickel and about the same quantity of cobalt are the annual requirements.

Chicago Section Meeting, A. C. S.

THE June meeting of the Chicago Section of the American Chemical Society was held on Friday, June 25, at the City Club.

Dr. L. V. Redman, in retiring from the chair spoke of the appreciation he felt toward the members of the society for the support they had given him during his regime. When he came into the chair he thought that the control of the section was sort of a closed ring or corporation, but found after two years' service that it was hard to get anyone into the ring, and that the corporation had to sell its stock on a poor market. He assured the new chairman, Dr. W. Lee Lewis, of the continued support, that he may be happy when he lays down the gavel of office.

Dr. Lewis, in taking the chair, said that by many political maneuvers he had now acquired the chairmanship, and that the Chicago Section must make the best of it. The chief concern of the section now is over the sixtieth convention of the American Chemical Society. The event places the Chicago Section as host in a most delicate position where vigor without violence is required. The mechanical work of the convention is progressing and the spiritual part is in the hands of the members of the section. While this convention is for the purpose of presenting papers, man is not essentially an intellectual animal, and the social side is therefore important. It is up to the Chicago Section to convince our visitors that we are democratic, friendly and genial. This lies in the hands of the members.

The Section committees for the coming year are as follows: Program committee, J. A. Hynes, chairman, David Klein, Frank DeBeers and Paul N. Leech; finance committee, Herbert N. McCoy, chairman, Robert J. Quinn and W. R. Smith.

Dr. Lewis spoke further of the splendid work done by the retiring chairman and group of quiet unselfish members back of this section. A rising vote of thanks was made to Dr. Redman for his service.

The paper of the evening was presented by Roy C. Coleman of the Essenkay Products Co., as follows:

Colloid Chemistry in Industry

There are certain well-founded criticisms against colloid chemistry to the effect that the colloid chemist generalizes too much. There is a divergence of opinion as to what colloid chemistry is and a review of the literature discloses the reason people think of it as a theoretical science. It is necessary to get away from usual theories to understand certain phenomena explained only by the colloidal theory.

In considering colloids, we first have a physical state of matter, and second, we have to do with the chemistry of material in that physical state. It is a state, not a kind, and an effect, not a cause.

We must not generalize, but define. Every phenomenon is not explained from a standpoint of colloid chemistry. What is the colloidal state? It is physically heterogeneous. Ostwald says: "It is the chemistry of neglected dimensions." Another writer calls it "dispersion chemistry" and another "the mathematics of chemistry." It is necessary, then, to have dispersion of one matter in another.

There are limits as to the size of the particles. The lower limits consist of mechanical mixtures with particles say 1 μ in diameter. The higher limits are molecular dispersions with the particles 0.1 $\mu\mu$ in diameter. The great field between these two limits contains particles said to be in colloidal state.

Emulsoids and Suspensoids

It is a state of matter, then, where one material is dispersed in another and this substance has the property of greater subdivision the nearer it approaches the mechanical solid and vice versa. It also possesses the property of great total surface of particles. We are not concerned as to why these matters disperse one within the other, but with the fact that they do disperse. If the particles are large they are called suspensoids and if smaller or approaching the upper limits they are called emulsoids. Emulsions may be either emulsoids or suspensoids.

Dispersion in Non-Aqueous Solutions

The literature deals largely with the dispersion of solids in aqueous liquids. The experience of the writer has been along lines of dispersions of solids or pigments in non-aqueous solutions like oils. We use certain things in the art because they have a definite physical state which is very often of greater importance than their chemical composition. Oils and varnishes, therefore, offer an excellent opportunity for the study of colloids.

Take for example oxidized linseed oil which is made a solid by heating or blowing air through the solution, or if it does not become solid it is at least very viscous. As these solids form, particle-surface increases. In suspensoids there is not much change in the viscosity of the solution but emulsoids will increase materially toward the solid state. There are many phases in these mixtures which depend upon the material and the dispersion medium.

This dispersion occurs without chemical action due to certain degrees of surface tension. The degree of dispersion depends on certain surface energy which causes the breaking up of the particles. This is particularly proven by placing pigments in oil. Certain liquids such as oils are of colloidal nature in themselves, and therefore tend to disperse the added solids more easily. Some of these colloidal liquids are in themselves of high viscosity.

Distinguishing Colloidal and Molecular Solutions

The application is found in the manufacture of oil cloth, where the solution is built up to a certain amount to get the rigid or solid material. The colloidal solution may be distinguished from molecular solutions by an observation of the action during this building up where viscosity is plotted against temperature. Molecular solutions show a straight line while colloidal solutions show a curve. There may even be a definite break in the curve were change occurs from the molecular to the colloidal state.

Solids may be dissolved in solids to get either colloidal or molecular solutions. Resins, gums, etc., are colloids themselves, and when mixed, may become either molecular or colloidal solutions in the fluid dispersion mediums. There are three different ways this works out with solids. Where the colloidal solid is soluble in the dispersion medium, molecular solution is formed, as when gums are dissolved in benzol or analogous compounds. If the solid disperses in the medium without breaking up we have the second state. Many gums do

this as a class in turpentine for dispersion medium, as the solid colloid is added.

The third class is where adsorption takes place to a certain limit, at which point the solid separates out from the solution. Shellac in alcohol is an illustration. If 6 lb. of shellac is dissolved in 1 gal. of alcohol, a viscous stable solution is formed. If more alcohol is added, for instance with a ratio of 5 lb. of shellac to 1 gal. of alcohol, a slight separation takes place and this will continue as more is added until all the shellac would separate out. Certain polymerides and varnishes act in a similar manner. This third condition, then, is a form of adsorption in which the solid is dissolving the liquid instead of the reverse. In practice this applies to many varnishes and protective coatings, and is of great importance in paint mixing.

Paints and Enamels

Colloidal oils may cause a very fine dispersion with zinc oxide, barytes, magnesium silicate, etc. Where a high colloidal viscosity is reached, a range of dispersion may be secured with zinc oxide in oil from 15 to 95 per cent, depending on the oil used. In the manufacture of body paints and fine enamels the dispersion must be very fine to secure proper smoothness on application.

In experiments with china clay, whiting, barytes, and silica as a class with a medium viscous oil, china clay was found to give a plastic paste, while with silica a viscous paste and liquid like molasses were obtained. This is caused entirely by a different degree of dispersion of materials. Solutions in rubber operate in the same manner as with oil. Hardness and elasticity are determined by the amount of dispersion.

We can, therefore, by a study of the viscosity of liquids and dispersion, find many things of practical importance. The practical laboratory tests for determining the colloidal condition or extent of viscosity due to colloidal condition may be determined by testing with adsorption of a certain strength of caustic soda. The word "absorption" is very much abused in this connection. Absorption is applied to any kind of taking up of material or liquid, as in the case of water in a sponge, while adsorption is a form of absorption like the taking up on the surface of the particles, as in a gel.

Chemists Studying Uses of Wool Waste

The Bureau of Chemistry, United States Department of Agriculture, has been carrying on experiments to determine profitable uses for the grease and other substances found in the scouring of wool.

Chemical analysis of a large number of samples of all grades and kinds of unscoured wool show that the percentage of grease varies widely even in the same grade or class, but is high in nearly all grades. In Ohio delaine, a very greasy wool, the grease varies from 17.8 per cent to 41.9 per cent. This means that in every hundred pounds of unscoured wool containing the highest percentage there is more than 41 lb. of grease. The profitable utilization of such an item is well worth the serious attention of the wool-scouring industry.

Tests of the suitability and adaptability of the grease to various uses, including leather dressing, waterproofing and manufacture of varnish and lanolin, are being made. There is a constant demand for lanolin for use in the manufacture of cosmetics and ointments. Methods for the economical recovery of potash, soapgrease and fertilizer are also being developed.

What Can Be Done With It?

A corporation recently organized to take over one of the large government powder plants for the purpose of selling the buildings and land in sections to new industries has found itself with several buildings of peculiar styles and construction apparently unsuited for peace time industrial purposes. Most of them, however, have been converted and utilized, with the exception of the building pictured herewith. The engineering and sales departments have racked their brains for an idea of what use this building can be adapted to, or what industry could utilize it, but without result. It seems ideally built for a concentrating plant but the fact that no minerals except soft coal are to be found

within several hundred miles does not make this seem feasible. A shot manufacturer might be interested were this field not already overfull. The owners have appealed for an idea and the problem is presented to our readers. Suggestions may be addressed to the editor.

There are five of these buildings in a row. The construction is frame with an elevator occupying the square offset. The dimensions are 40 x 40 x 80 ft. high to top of roof truss; to extreme top is 112 ft. The chute down in the foreground was to be used by the workmen as a fire escape, the building being used for blending gun powder. The interior is of tin construction.

Say "Flammable," Not "Inflammable"

The National Safety Council, the National Fire Protection Association and similar organizations have set out to discourage the use of the word "inflammable" and to encourage use of the word "flammable" instead. The reason for this change is that the meaning of "inflammable" has so often been misinterpreted. Some persons have thought of the first two letters of this word as the prefix "in," meaning "not," or "non-," as in "inactive" (not active) or "incontrollable" (not controllable). "Flammable" is shorter, more definite and cannot be misunderstood. The negative of "flammable" is "non-flammable."

Legal Notes

By Wellington Gustin

Correspondence and Telegrams Held to Constitute a Valid Contract

How a mass of correspondence, telegrams and such may, together, constitute an agreement or contract is shown in the suit of the National Smelting Corporation against Cutler Bros. and the Superior Metal Co. Action was brought to recover damages for breach of an alleged contract to sell and deliver to the smelting company, within a reasonable time, 25 long tons of Chinese No. 1 tin, minimum 99 per cent pure, at 82c. per pound c.i.f. Pacific Coast. It appears that prior to the time of delivery defendants gave notice that they would not fulfill their agreement, but would repudiate it, whereupon plaintiff was obliged to buy the tin in the open market and pay 91c. per pound. The case was discontinued as to the Superior Metal Co. upon the showing that it was only a broker in the transaction.

There were various letters and telegrams passed between the parties, beginning with the telegraphic offer of the Superior Metal Co., of New York, to Emar Goldberg, at San Francisco, on April 6, 1918, advising him that a firm bid would probably secure "25 Chinese" on steamship Canada, reported to have sailed on March 26 from the Far East, at 82c. per pound on the Pacific Coast. Goldberg replied that his party thought the price was high, but would accept confirmation at 82, and asked the broker to try to secure a price of 81 and wire confirmation to National Smelting Co., San Francisco, which he said was "O.K." On April 8 the broker telegraphed the National Smelting Co., confirming the purchase for it of "25 Chinese tin," as per telegram of April 6, at 82c., sellers Cutler Bros., and said, as its name was unknown in New York, it was requested to telegraph references. The smelting company did this, referring to the First National Bank in San Francisco. This was further confirmed by letter dated April 8. Now, on the same day, the broker (Superior Metal Co.) telegraphed the smelting company, asking it to have the bank telegraph a guarantee of payment on presentation of documents on arrival of the tin at the Pacific Coast, as it had no rating, and Cutler Bros. were becoming impatient, as they could sell the tin in New York at 86c.

More Letters and Telegrams

In the meantime the smelting company had written the broker confirming its telegram, giving its bank references and further confirming its purchase of the tin. On April 9, it sent the broker a telegram saying it was prepared to take care of the draft on arrival of the tin. Goldberg also telegraphed the broker that Cutler Bros. would be held to the contract if the tin was not delivered. The broker prepared contracts and sent them for acceptance of the smelting company. These were accepted and returned, but were never signed by Cutler Bros. On April 12, Cutler Bros. wired the First National Bank of San Francisco, asking if it would guarantee to pay their draft for twenty-five tons of Chinese tin sold National Smelting Co. On the same day Cutler Bros. wrote the broker, quoting this telegram, saying that unless they received answer from the bank that day, they would not sign the contract prepared by it, but would return such contract and consider same cancelled. The bank replied on April 13, accepting the order for payment of the draft, saying guaranty was unnecessary.

On April 17, the bank sent a telegram to Cutler Bros., advising them that the bank had opened a credit in their favor for $50,000 for the account of the smelting company to cover drafts as shown by the bills of lading attached, calling for the tin. On April 18, Cutler Bros. wired the bank that they would not accept the guaranty at that time. In the meantime, the smelting company had telegraphed the broker (on April 16) that the bank guarantee was no part of the contract, but, to avoid trouble, it had gotten guarantee.

Valid Contract Established, Says Court

The series of telegrams and letters was held by the trial court not to constitute a contract valid and existing between the parties, but the Supreme Court of New York, Appellate Division, thought otherwise, and reversed judgment of the lower court. It said all the necessary elements of a valid contract appear to have been understood to be present by the parties, and nothing was left to any future agreement. Cutler Bros. did not claim that the written contract, drawn up by the broker metal company, did not contain all the elements of a contract as agreed upon by the parties in conformity with the telegrams, and the refusal to carry out the contract by Cutler Bros. was due solely to the failure to furnish them with a bank guarantee, said the court.

When a valid and binding contract had been made between the parties, neither had the right to impose other conditions. The additional condition for a guarantee (and not a reference) was made by the sellers, Cutler Bros., apparently in the hope, says the court, that it might furnish a pretext to break the contract, as they desired to obtain a higher price for the tin on a rising market. They insisted on an immediate reply and claimed same came too late, though the buyer was under no obligation to do anything further, but yielded in its desire to receive the tin it had bought in good faith.

Delivery Delay Excused by Mandatory Order from Government Where Contract So Stipulates

The Supreme Court of New York, in Appellate Term, has ruled, on a case appealed to it, that the seller, having taken an order "subject to war hazards and to delays due to Government action over which the seller has no control," was not required to make delivery of the products within the time specified in the contract of purchase, where he was unable to do so because of a mandatory order from the Government for a large portion of his June product. (180 N. Y. S., 447.)

Where the seller brought an action to recover for buyer's refusal to accept goods, and the buyers defended on the ground that the goods were not delivered within the time specified in the contract, it was a question of fact, to be determined from evidence, whether the buyers had by their conduct led the seller to believe that delivery within the contract time had been waived.

Again, where the buyer's conduct had led the seller to believe that delivery within contract period was waived, the seller would be entitled to a reasonable time notice of a new delivery date before being held in default.

Properties and Constitution of Glues and Gelatines—II

The Effect of Electrolytes Upon Degree of Dispersion; and the Structure of Gelatine Sols—Action on Viscosity Not Regular—Protein Ions—Thread-like Structure—The Relation of Melting Point to Viscosity of Jell Strength*

By ROBERT H. BOGUE, Ph.D.

THERE is considerable evidence tending to indicate that viscosity is very greatly influenced by degree of dispersion, and many facts even suggest that many of the previously described factors[12] affecting viscosity do so through the medium of producing a change in the degree of dispersion.

The relation between viscosity and degree of dispersion does not, however, appear to be a simple one. Throughout the literature on the subject one finds the citations about equally divided between those who obtain a decrease in viscosity with a decrease in degree of dispersion, and those who find the ratio to vary inversely. Wo. Ostwald[13] arrives at the conclusion that "other conditions being constant, a dispersoid reaches its highest viscosity at a medium degree of dispersion," but adds that "the experimental verification of such a conclusion is a problem of the future." Results obtained in the present investigation not only confirm this point of view but perhaps may furnish a part of the "experimental verification" desired by Ostwald.

The structure of solutions of the proteins has long been a rife subject for speculation, and some of the work described herein has led to the presentation of a modification of the net-structure theory.

The Effect of Electrolytes Upon the Degree of Dispersion

In testing the effect of several electrolytes on jell strength, it was found[14] that in nearly every instance the presence of the electrolytes decreased the jell strength, there being in some cases a preliminary slight increase. There may conceivably be three ultimate reasons for such a depression:

The degree of dispersion may be increased. It is reasonable to assume that a molecularly dispersed system would be of more nearly a watery consistency and would not jell.

The degree of dispersion may be decreased. We have direct proof that the jell strength is considerably lowered and may even remain liquid, when the degree of dispersion is so far decreased as to result in visible flocculation.

The protein molecules may have undergone hydrolysis. This point was tested by precipitating the protein of a glue, after it had been in contact with different salts for some time, in a 35 per cent saturated solution of magnesium sulphate. The per cent of nitrogen thrown down in the precipitate was in each case greater than that of the control to which no salt was added, as is shown in Table XX.

In the light of the information obtained from a large number of experiments on the magnesium sulphate precipitation of the proteins of glue,[15] it becomes permissible to conclude that the added salts do not produce any cision or hydrolysis of the ultimate protein molecules themselves. We conclude, therefore, that the lowering of the jell strength may be due either to an increase or a decrease in the degree of dispersion.

Action on Viscosity Not Regular

The effect of the added substances on viscosity[16] is not so regular as the effect on jell strength. We find these substances arrange themselves into four groups with respect to their action on viscosity

Those which raise the viscosity constantly.

Those which lower the viscosity constantly.

Those which raise the viscosity to a maximum, beyond which they produce a drop.

Those which have no appreciable effect.

In studying the causes of this irregularity of action, we are especially aided by the third class, which produce first a rise followed by a decrease in viscosity. Sodium hydrate and acetic acid when added in regularly increasing amounts produce a noticeable increase in turbidity, a decided increase in viscosity and quite suddenly a sharp drop to a solution of water consistency. Very shortly after this drop begins visible flocculation occurs, which is reasonable evidence that the process has been accompanied throughout by a continuing decrease in degree of dispersion. But as the degree of dispersion decreases beyond a certain optimum size, the direction of the viscosity curve changes. This shows, therefore, that both an increase and a decrease in viscosity may accompany a continually decreasing degree of dispersion. It also shows that the degree of dispersion which is optimum for maximum viscosity is not the same as that which is optimum for maximum jell strength.

TABLE XX. EFFECT OF ADDED SUBSTANCES ON HYDROLYSIS
35 Per Cent Saturated $MgSO_4$. ½ c.c .1-4 H_2SO_4.

Glue H_4	Per Cent of Total N	Glue H_3	Per Cent of Total N
Control	57.9	Control	72.5
33 per cent $MgCl_2$	67.2	33 per cent $MgCl_2$	74.1
33 per cent KI	65.5	33 per cent aluminum alum	75.2
33 per cent CH_3COOH	60.9	33 per cent chrome alum	75.1
33 per cent chloral hydrate	58.7	33 per cent formalin	74.1

If the attempt is made to explain the action of those substances which constantly raise or constantly lower the viscosity, it may be expressed in the same terms. Magnesium chloride and chloral hydrate both increase the viscosity constantly. We may assume that the mechanism by which they do this is by decreasing the degree of dispersion. The reason why such high values are obtained with them in contrast to the much smaller maxima obtained by sodium hydrate and acetic acid is probably due to the great velocity of the change in the

*For Part I, see Chem. & Met. Eng., vol. 23, No. 1, p. 5, July 7, 1920.

[12] See p. 11.

[13] Ostwald, "Handbook of Colloidal Chemistry," 1st Ed., (1915), p. 177.

[14] See p. 11.

[15] See Part III.

[16] See p. 11.

latter cases, which brings the viscosity past its maximum in a very brief interval of time, whereas with the former the change is gradual.

In the case of the nearly regular decreases in viscosity obtained on adding sulphuric and phosphoric acids, there are indications that they pass through a maximum point attained very rapidly on the addition of only traces of the acids, and that further additions produce further decreases in dispersion, but at a rate comparatively slow. Eventually, however, a visible separation of a flocculent precipitate occurs.

The action of potassium iodide appears to be different. In this case the solution resulting from its addition to a glue has a watery consistency, but does not, even on long standing, show any signs of precipitation. The solution becomes less turbid, it filters more readily, the "protective" action of the gelatine on preventing precipitation of insoluble salts becomes markedly less and, in general, it shows to a much greater degree than the control the properties of a molecularly dispersed system. It seems, therefore, reasonable to conclude that the addition of potassium iodide to a glue or gelatine results in an increased degree of dispersion, with the attendant decrease in both viscosity and jell strength.

The last class of substances, e.g., those which have no appreciable effect on viscosity, should, according to our argument, have no appreciable effect on jell strength. This conforms with the results obtained.

Structure of Gelatine Sols

As yet no attempt has been made to define the intramolecular mechanism by which a change in degree of dispersion is brought about, not to speculate upon the specific structure which the colloidal aggregates are assumed to possess. Considerable evidence has been presented in the literature[17] intending to show the presence of a net-structure in protein solutions. The presence of such a structure would unquestionably reveal itself in producing a high viscosity, for a net structure would offer a considerable resistance to any force involving the deformation of that structure, and viscosity, as it is usually determined, by pouring the liquid through a capillary tube, or by the rotation within it of a suspended disk, would involve such a deformation. This was shown by Garrett[17] who found that "the logarithmic decrement of a disk oscillating in a gelatine solution is not a constant, as it is in water or other homogeneous fluids, but, on the contrary, increases as a linear function of the time. This was traced to adhesion between the disk and the protein; if the disk was taken out of the fluid and washed the initial value of the decrement was always the same." He assumed that proteins of the net structure adhered to the oscillating disk.

The writer has shown[18] that mechanical agitation and preliminary heating also decrease the viscosity, and Garrett[19] found that in a solution of gelatine which had been boiled the logarithmic decrement of an oscillating disk did not increase with time, but remained constant. These all point to the fact that the net-structure may be more or less destroyed by mechanical agitation and heat, and conversely contribute toward the support of a theory of an extraordinary structure of some kind in the solutions of gelatine.

But as we are especially concerned here with the relations between viscosity and degree of dispersion, the questions should be considered: What is the internal mechanism by which a change in degree of dispersion, and consequently of viscosity, is brought about? How is one to regard a change in degree of dispersion when applied to a molecular net-structure? And if such a structure does not satisfy the conditions, what modifications to the theory are necessary?

J. van Bemmelen[21] has said: "The formation of flakes which are precipitated in a liquid is dependent on a change in the surface tension of the liquid membranes surrounding the colloid particles, of such type that these membranes between the particles are torn at some point, thus permitting the particles to form aggregates." And Wo. Ostwald[22] states that "the relation of positive to negative surface tension between the disperse phase and dispersion medium determines the degree of dispersion." It has been shown by W. Frei[23] that gelatine diminishes the surface tension of water; that the surface tension of a gelatine solution is increased by the addition of small quantities of alkali, and diminished by the addition of small quantities of acid; and that the addition of the anions SO_4, Cl and NO_3 and the cations Na, K, Mg and Ca increase the surface tension of a neutral gelatin solution in the order given. J. Loeb[24] has, however, recently shown that all such determinations are valueless unless performed either directly at the isoelectric point (for gelatin 2×10^{-5}N) or at an exactly determined hydrogen ion concentration above or below this point,[25] and in the absence of an excess of electrolyte.

Protein Ions

These investigations establish beyond any doubt the correlation between degree of dispersion and surface tension, but it has also been shown by many workers[26] that acids and bases combine with the proteins resulting in the formation of protein ions. The older belief was that these were formed only by the combination of the end $-NH_2$ and -COOH groups of the polypeptide chains, but an abundance of evidence has been brought to bear against this view, to the end that the -CONH- groups within the molecule are to a preponderant degree responsible for such combination. And not only acids and bases, but also neutral salts have been shown[27] to contribute to the formation of protein ions.

We are therefore led to the conclusion that *the addition of electrolytes to a gelatin solution may, and usually does, result in the formation of protein ions, and that the electrical condition resulting within the solution from this ionization produces a change in the relation of positive to negative surface tension between the disperce phase and the dispersion medium, and that this change, in turn, affects directly the degree of dispersion of the disperce phase, or gelatin molecules. The alteration of the degree of dispersion reveals itself*

[17] Garrett, *Phil. Mag.*, 6th Ser., vol. 6 (1903), p. 374. Wo. Ostwald, "Handbook of Colloidal Chemistry," 1st ed., (1915). Sutherland, *Proc. Roy. Soc. London*, vol. 79B (1907), p. 130. Hardy, *Am. J. Physiol.*, vol. 24 (1899), p. 158.

[18] *Loc. cit.*, cited after Robertson "The Physical Chemistry of the Proteins," 1st ed. (1918), p. 327.

[19] See p. 6.

[20] *Loc. cit.*

[21] "Die Absorption" Gesammelte Abhandl., Dresden (1910), p. 22. Cited after Ostwald, *op. cit.*, p. 88.

[22] *Op. cit.*, p. 181.

[23] "Zur Theorie der Haemolyse," *Diss.*, Zurich (1907).

[24] *J. Gen. Physiol.*, vol. 1 (1918-19), pp. 39, 237, 363, 483, 559.

[25] The determinations upon which this discussion is based were performed at the "neutral point," as determined by litmus (H^+ ion concentration $= 0.0_5 1$).

[26] Blasel and Matula, *Biochem. Z.*, vol. 58 (1914), p. 417. Pauli and Hirschfeld, *idem*, vol. 62 (1914), p. 245. Robertson, *op. cit.*, p. 20. Loeb, J., *loc. cit.*, pp. 483, 559.

[27] Pfeiffer and van Modelski, *Z. physiol. Chem.*, vol. 81 (1912), 239; and vol. 85 (1913), p. 1. Loeb, J., *loc. cit.*

then in a change in the physical properties, as melting point, viscosity, and jell strength.

In the light of this rather broad generalization we may speculate upon the probable structure of the colloid aggregates of the protein molecules. There seem to be some difficulties in the net-structure conception. If the molecules are considered as forming only the intersections of this hypothetical "net," and the "connecting threads" being merely lines of force which tend to bring the molecules together, touching each other at certain points, with perhaps a thin film of the dispersion medium between, then, according to W. H. and W. L. Bragg,[28] the conditions would be met for the formation of a crystalline structure. But no such homogeneously built product results. Again, if the molecules be represented as forming both the intersection points and also the connecting threads of the "net," one is put to some trouble to visualize the phenomena attending an alteration in degree of dispersion. If a decrease in degree of dispersion is conceived of as a coalescence, then wherefore should the process become discontinuous with the formation of flakes? If the process consists only of aggregation, then the surface tension phenomena, coming into play, would eventually result in a separation of the dispersion medium from the disperse phase, leaving the system composed of two liquid phases, or a solid and liquid phase, with a clear line of demarcation between. The occurrence of syneresis with solid jells is of course well known, but it is not known to generally occur in the liquid sols.

Thread-like Structure

But, as has already been pointed out, there is an abundance of evidence pointing toward some kind of an extraordinary structure in protein solutions, so that we are not permitted to regard them as consisting of discrete particles, of the same nature as true solutions. It seems altogether probable to the writer that the disparities between the behavior of protein solutions and the proposed theories of structure may be to a great extent harmonized by conceiving the colloid aggregate as of a thread-like, or streptococcal, structure. The latter similus seems especially to give a clear picture of the situation. The protein molecules may be regarded as the individual cocci, the colloid aggregate as the streptococcic thread. An alteration in the degree of dispersion could now easily be interpreted as consisting of a change in the length of these threads, many uniting to form one, or one breaking into several. If the force tending to unite them were great, cohesiveness[29] might also become a factor, and as the surface energies between the solute and solvent becomes less,[30] a flocculent precipitate may result. Indeed Bordet[31] and Arkwright[32] both have pointed out that acid agglutination of bacteria belongs to the same class of reactions as the coagulation by hydrogen ions, or electrolytes, of amproteric colloids. The behavior of the proteins which led to the belief of the existence of a net-structure in their solutions may be explained with equal ease by the streptococcic structure hypothesis, while, in the congealed state, the maze of intermingled threads would readily account for an apparent net-structure. A deformation of this thread-structure would reveal itself similarly in producing an abnormally high viscosity, and Garrett's[33] findings that the logarithmetic decrement of a disk oscillating in a gelatine solution was not a constant would be explained by an entirely similar manner.

The conception of ionization is especially benefited by the thread-structure conception. Robertson[34] has pointed our a serious inconsistency in the net-structure theory. He recalls that the viscosity is said to be due to a net-structure, and that it is also attributable, primarily, to the protein ions. This also conforms precisely to the findings of Loeb.[35] Therefore, the net-structure within the protein solution must be built up of protein ions. But, he goes on to say, "such a conclusion is totally out of harmony with the prevailing view that ions, in solutions of electrolytes, are mutually independent and physically discrete bodies, and would appear to invite a distinction between the mode of ionization of ordinary electrolytes and that of protein salts." But if we regard a neutral "streptococcic thread" of protein molecules as capable, by a chemical reaction, of forming a protein salt, and this salt, in turn, of ionization, the identity of the "streptococcic thread" need not be lost, and it is still an independent and physically discrete body, capable of developing osmotic pressure, of conducting the electric current, and, in general, of carrying out the reactions associated with ions in electrolytes.

It should be added that these threads need not be considered as of great length, except in special cases. A small number of such molecules or ions combined in this manner is sufficient to account for the experimental facts. It is of especial interest to note that Loeb,[36] in accounting for the ratio of 1:3 in the osmotic pressure of calcium gelatinate and sodium gelatinate states, "It is in reality only necessary to assume the existence of compounds of the form Ca (gelatin)$_2$, the two anions of which form one aggregate of two gelatin anions, and to assume further that two, three or more such aggregates of two gelatin anions join to form larger aggregates of four, six, or eight gelatin anions, every one of which keeps its original charge. This would account for all the phenomena observed." Bayliss[37] offered a somewhat similar explanation in accounting for abnormal osmotic pressures with respect to the electric dissociation of solutions of Congo red, namely, "the possibility of aggregated simple ions carrying the sum of the charges of their components."

It is well known, however, that the viscosity of gelatin solutions increases by standing at low temperatures, and, from our knowledge that heating breaks up whatever structure exists, it seems reasonable to expect that this protracted standing at low temperatures may produce the opposite effect, and produce exceptionally long threads, which formation, in turn, is revealed by the high viscosities obtained.

In the light of these reflections it seems reasonable, therefore, to conclude that a modification of the net-structure theory, to the end that the colloid aggregates of protein molecules be considered as united into a "streptococcic thread," accounts somewhat more adequately than the older theories for the several phenomena attendant upon ionization, changes in surface tension, degree of dispersion, viscosity, etc.

[28] "X-Rays and Crystal Structure," London, 1915.
[29] Wood and Hardy, *Proc. Roy. Soc. London*, vol. 81B (1909), p. 38.
[30] See W. Ostwald, *op. cit.*, p. 83.
[31] *Cent. Bakt.*, vol. 54 (1910), p. 150.
[32] *Z. Immunitat.*, vol. 22 (1914), p. 396.
[33] *Loc. cit.*
[34] *Op. cit.*, p. 325.
[35] *Loc. cit.*
[36] *Loc. cit.*, vol. 1 (1919), p. 496.
[37] *Proc. Roy. Soc. London*, Series B, vol. 84 (1911), p. 253.

To summarize upon the effect of electrolytes on degree of dispersion; and the structure of gelatine sols, it has been shown that:

Glues in general are at their optimum degree of dispersion for maximum jell strength.

Glues are below their optimum degree of dispersion for maximum viscosity.

Whenever a substance is added to a glue which produces a decrease in the degree of dispersion, this change is accompanied by an increase in viscosity until a certain optimum size of molecule has been reached, beyond which point the viscosity falls rapidly.

Whenever a substance is added to a glue which produces an increase in the degree of dispersion, this change is accomplished by a decrease in viscosity.

Electrolytes in general produce a decrease in the degree of dispersion: The hydrogen ion acts very rapidly, the hydroxyl ion acts more slowly, and salts in general act slowly.

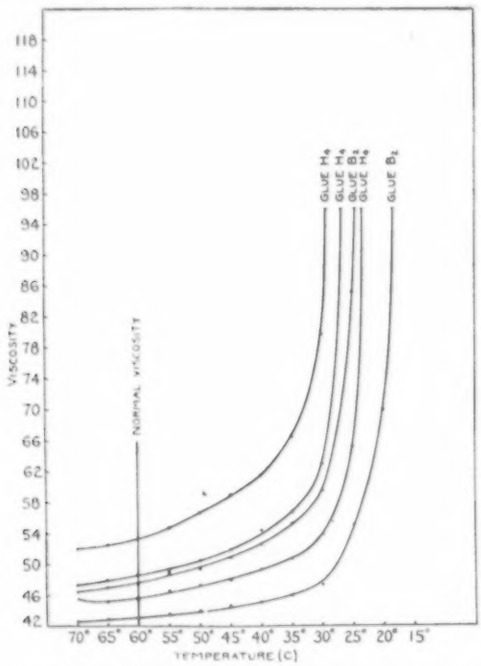

FIG. 11. THE RELATION OF NORMAL VISCOSITY TO MELTING POINT

Some salts, e.g., potassium iodide, may produce an increase in the degree of dispersion.

The internal mechanism by which these changes are brought about in the solution is shown to involve ionization of the protein, an alteration in surface tension, and a change in degree of dispersion.

Inconsistencies in the net-structure theory are pointed out, and a modification in favor of a "streptococcic structure" is proposed.

Many methods have been suggested for the determination of the melting point of viscous substances, but few of these appear to have any value in their application to glues and gelatines. Indeed, the change from a firm solid through varying degrees of hydration and phases of viscid semi-mobility to a true colloidal solution are so gradual and uniform that it becomes difficult to apply the term melting *point* at all, even theoretically. In the present paper an attempt is made to establish a satisfactory method for the measurement of *relative* melting points of glues and gelatines, and to determine the relation which exists between this value and the jell strength and viscosity in these substances.

If one may assume as a *measure* of melting point that degree of viscidity at which a glue will no longer flow through the narrow orifice of a viscosimeter tube, then it becomes an easy matter by taking a series of viscosity readings at decreasing temperatures to plot the point at which the rate of flow would be zero. For comparative purposes, however, it should suffice only to plot the values actually obtained and note the relative rates at which the curves tend to approach the vertical (time of flow = infinity). Thus, if the curve of one glue tends to approach the vertical more rapidly than another, as both are reduced through equal intervals of temperature, then the former has the higher melting point.

Working on this principle, two series of glues were selected, those within each series being of the same jell strength but of different normal viscosity. These were examined for viscosity at 5 deg. temperature intervals between 70 and 15 deg. C.

Relation of Viscosity to Melting Point

The data obtained, when plotted, show unmistakably that the higher the normal viscosity (at 60 deg. C.) of a glue, the more rapidly does it approach the vertical (infinite slowness of flow) with reduction in temperature, which means in the terms of our experiment that the melting point varies directly as the viscosity, or that the viscosity is a function of the melting point.

TABLE XXI RELATION OF VISCOSITY TO MELTING POINT

Concentration, 30 g. glue to 180 g. total weight

Temperature	Grade H_4			Grade B_2	
Deg. C.	1	4	7	8	11
70	45.8	47.4	52.0	42.6	46.4
65	45.4	48.0	52.6	43.0	47.0
60	45.8	48.8	53.8	43.2	47.8
55	46.6	49.4	54.8	43.8	49.0
50	47.4	50.6	56.8	44.0	49.6
45	48.0	52.0	59.0	44.8	51.0
40	49.6	54.4	61.8	45.2	52.8
35	50.8	56.8	66.6	46.0	55.4
30	54.0	63.0	79.8	47.6	59.8
25	65.2	139.6	Set	55.2	85.4
20	140.0	Set	....	70.0	Set
15	Set	.....	....	Set	....

Graphical representations of the above are shown in Fig. 11.

In order to determine if the jell strength was also related in any way to the melting point, another series consisting of five glues of uniform normal viscosity but varying jell strength was run in the same manner as above. If the melting point was concerned only with the viscosity at 60 deg. C. and not with jell strength, then the viscosity runs should remain practically constant throughout the changes in temperature and set at the same temperature.

The data obtained show that from 70 deg. to 35 deg. the viscosity remained practically constant throughout the series. At 30 deg., there began to be some divergence, which at 25 deg. became very pronounced, the glues varying in their viscosities at this temperature as their jell strength. At 20 deg. all were too thick to run except the glue with the lowest jell strength.

Jell Strength

It seems, therefore, that the jell strength is also a function of the melting point, but it should be pointed out that the variation due to differences in jell strength at a uniform normal viscosity are not so great as the variations due to differences in viscosity at a uniform jell strength.

A method described by A. Wayne Clark and Louis

Du Bois[28] has as its object the determination of "jelly value" in terms of the minimum percentage of glue or gelatine which will remain in solid phase when, after putting into solution and cooling to well below 10 deg. C., it is brought gradually up to 10 deg. C. This appeared to be more of a determination of melting point than of any other physical constant, and so was tried out in an attempt to corroborate the above conclusions.

TABLE XXII. EFFECT OF JELL STRENGTH ON MELTING POINT

Concentration, 30 g. glue to 180 g. total weight

Number. Jell Strength, Deg. C.	1	2	3	4	5
	63	64	66	68	70
70	45.8	45.0	45.2	45.2	45.2
60	46.0	45.6	46.2	46.8	46.2
50	47.8	47.4	48.0	48.0	48.0
45	48.8	48.4	49.2	49.0	49.0
40	50.4	49.8	50.8	50.6	50.2
35	52.4	51.4	42.8	53.0	52.6
30	56.0	56.8	58.4	61.0	58.6
25	64.8	71.0	72.8	92.2	96.6
20	105.4	Set	Set	Set	Set

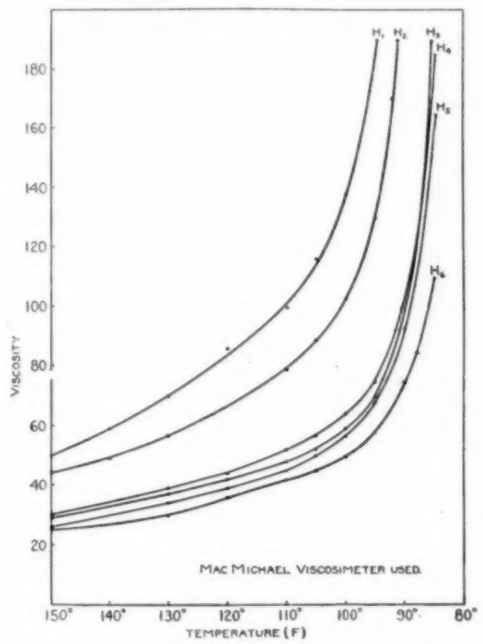

FIG. 12. THE EFFECT OF TEMPERATURE UPON THE VISCOSITY OF HIDE GLUES

Three sets were run by this method: 1—the standard glues of Grades H_2, H_3, H_4 and H_5; 2—three glues which were of uniform jell strength but varying viscosities; 3—five glues which were of uniform viscosity and varying jell strength.

TABLE XXIII. RELATION OF "PER CENT JELLY VALUE" TO VISCOSITY AND JELL STRENGTH

	No.	Grade	Viscosity	—Percentage Glue Added— 2	3	4	5	Per Cent Jelly Value
Standard Grades	2	H_2	54.0	s	s	s	s	2
	3	H_3	50.8	ss	s	s	s	2½
	4	H_4	49.4	l	l	s	s	4
	5	H_5	48.0	l	l	l	s	5
Uniform jell strength, varying viscosity	1	H_1	45.6	l	l	ss	s	4½
	4	H_4	49.0	l	l	s	s	4
	7	H_7	55.0	l	ss	s	s	3½
Uniform viscosity, varying jell strength	1	63	46.2	l	l	l	ss	5½
	2	64	45.8	l	l	ss	s	4½
	3	66	46.0	l	l	ss	s	4½
	4	68	45.8	l	ss	s	s	3½
	5	70	46.2	l	s	s	s	3

Note: s=solid; l=liquid; ss=semi-solid

The results show the "per cent jelly value" to vary inversely with the jell strength in the standard grades, but in the glues of uniform jell strength and varying viscosity there was also a uniform variation, the glue with the highest viscosity remaining solid with the lowest percentage of glue. The glues of uniform viscosity and varying jell strength also varied, the "per cent jelly value" being in inverse ratio to the jell strength.

These results are in every way identical to those obtained by the first method described, and lend additional evidence to the conclusions derived from that set of experiments.

Another method described by C. Frank Sammet[29] has as its object the determination of jell strength by the direct observation of the comparative melting points of the granulated glues. These are soaked in cold water for 1 min., then small amounts placed near the end of a brass strip and the tip of the latter held in water at 40 deg. C. The comparative melting points are noted by observing the order in which the glues melt under these conditions. In order to obtain further confirmation of our conclusions, this method was tried out. The same three series of glues were used as in the previous experiment. The standard grades melted regularly in order of their grade, beginning with the lowest. The glues of equal jell strength and varying viscosities also varied, and regularly, the glues melting in the order of increasing viscosities. But among those glues of equal normal viscosities and varying jell strength, no regular variation could be noted by the method described. Flakes of each glue were then allowed to soak over night in water at 10 deg. C., and small portions of the resulting jell treated as described. The same results were obtained as before. A jelly was then made in 1 to 5 solution and portions of this treated as described. This time the melting point varied regularly in order of increasing jell strength, but this variation was very slight. The reason of failure to obtain a uniform variation in the first two trials was probably due to differences in the thickness and hardness of the par-

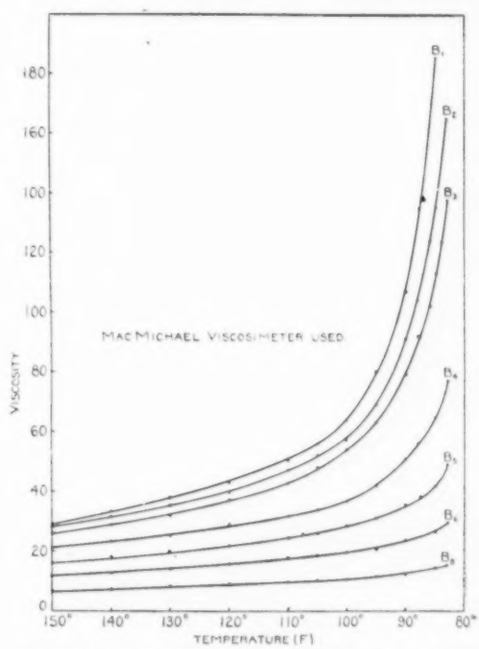

FIG. 13. THE EFFECT OF TEMPERATURE UPON THE VISCOSITY OF BONE GLUES

[28] *J. Ind. Eng. Chem.*, vol. 10 (1918), p. 707.

[29] *Idem*, vol. 10 (1918), p. 595.

ticles and the ease of hydration. No. 4, which melted first, was very thin cut and produced a clear transparent jelly. The others were more firm and opaque.

The final results on this set of experiments are entirely analogous to those obtained by the other methods.

TABLE XXIV. RELATION OF JELL STRENGTH AND VISCOSITY TO MELTING POINT

		Grade	Jell	Visc.	Order of Melting
Standard grades	2	H_2	..	54.0	4th
	3	H_3	..	50.8	3rd
	4	H_4	..	49.4	2nd
	5	H_5	..	48.0	1st
Uniform jell strength, varying viscosity	1	H_1	65	45.6	1st
	2	H_2	65	47.2	2nd
	3	H_3	66	48.0	3rd
	4	H_4	66	49.0	4th
	5	H_5	66	50.2	5th
	6	H_6	64	51.0	6th
	7	H_7	64	55.0	7th
	8	B_2	68	43.2	1st
	9	B_3	70	45.8	2nd
	10	B_4	70	47.0	3rd
	11	B_5	70	48.0	4th

				Granulated	Cold Water Jell	1–5 Jelly
	1	H_1	63	46.2	2nd	1st
	2	H_2+	64	45.8	4th	2nd
	3	H_4	66	46.0	3rd	3rd
	4	H_3+	68	45.8	1st	4th
	5	H_5	70	46.2	5th	5th

Viscosity and Temperature

In order to ascertain if the viscosity increased proportionately to the decrease in temperature for all glues, all grades of both hide and bone glues were measured for viscosity at temperatures from 150 to 83 deg. F. in the MacMichael viscosimeter.[40]

An examination of these results, shown in Table XXV, and expressed graphically in Figs. 12 and 13, reveals that in the bone glues the viscosity varies regularly from the highest to the lowest grade at every temperature. In other words, the viscosities are all normal. In the hide glues, however, there is one exception to this, e.g., glue H_2 is of abnormally low viscosity, lower at most temperatures than glue H_4, which it should normally exceed. It will be seen, however, that as the temperature of setting, or melting point, is approached, e.g., at 86 deg. and below, the viscosity of glue H_4 is greater than that of glue H_3, which is what one would expect if jell strength is a function of melting point, as seems to be the evidence of the previous experiments. In all other cases in this series the viscosities are normal at all temperatures.

TABLE XXV. VISCOSITIES OF STANDARD GLUES AT VARYING TEMPERATURES (MacMICHAEL VISCOSIMETER USED)

Temperature Deg. F.	Hide Glues						Bone Glues						
	H_1	H_2	H_3	H_4	H_5	H_6	B_1	B_2	B_3	B_4	B_5	B_6	B_7
150	50	44	29	29	26	25	29	28	26	21	16	12	7
140	59	49	33	33	30	28	33	32	29	23	18	13	8
130	70	57	37	39	34	30	38	35	32	25	20	14	9
120	86	68	42	44	39	36	43	40	37	29	22	16	9
110	100	79	48	52	45	42	51	47	43	32	25	18	10
105	116	89	52	57	50	45	56	52	48	34	26	19	11
100	138	103	59	64	57	50	64	57	54	37	29	20	11
95	188	130	70	75	68	58	80	69	63	42	31	21	12
90	...	210	100	100	93	75	107	91	79	51	36	24	13
88	...	...	120	122	112	85	133	104	92	56	38	..	..
86	...	...	162	155	143	100	165	124	102	..	..	..	..
85	...	...	205	185	165	110	186	136	113	65	42	27	15
83	...	...	...	...	...	...	...	165	138	77	49	30	16

Many further runs were made of sets having uniform jell strengths and varying viscosities, and of sets having uniform normal viscosities and varying jell strengths, but as these all point to the same conclusions and only corroborate data already obtained they will not be tabulated.

From these several experiments it seems pertinent to draw the following conclusions upon the relation of melting point to viscosity and jell strength:

If the jell strength remain constant, the viscosity will vary as the melting point.

If the normal viscosity be constant, the jell strength will vary as the melting point.

In normal glues wherein the viscosity varies as the jell strength, the so-called "grade," which is nearly always based primarily upon jell strength, will of course vary as the melting point, but in many glues wherein the viscosity is abnormal to the jell strength the melting point will represent the resultant of those factors which control the viscosity and jell strength, and a "grade" based upon melting point methods would in such cases presumably represent a closer approximation of the true value of the glue than is usually obtained by the present methods.[41]

Inasmuch as it has been shown herein that jell strength and viscosity are *both* functions of the melting point,[42] it is suggested that melting point methods be substituted for the customary examinations of jell strength and viscosity in the grading of glues.

As it has further been shown that a measurement of the viscosity at low temperatures[43] is in effect a measurement of melting point, it is suggested that this method be used, and the MacMichael viscosimeter is recommended as an instrument by which such measurements may be carried out with the greatest degree of speed and accuracy. Such a procedure will also eliminate the necessity of maintaining a set of standard grade glues in the laboratory, as the instrument may be standardized against any common viscid substance.[44] There is thus obtained a decided saving in time, space and labor, a better control of conditions, greater accuracy, and a truer evaluation of product than by the use of the old and time-honored methods.

(Part III, on The Relations Between Physical Properties and Chemical Constitution, and The Influence of Size of Molecule Upon Physical Constants, will be printed in a subsequent issue.)

Use of Sulphur Dioxide in Candy Prohibited in Pennsylvania

Chocolate-covered cherries containing sulphur dioxide have been found offered for sale in the Pennsylvania market. As this is in direct violation of the law pertaining to adulteration and use of preservatives in food, Director Foust of the Pennsylvania Department of Agriculture, Bureau of Foods has taken the matter up with the confectioners' organization in the state and the trade papers calling attention to the fact that the Pennsylvania food laws specifically prohibit the sale of any confectionery containing sulphur dioxide regardless of the quantity.

The majority of the manufacturers have announced that they will use no sulphur dioxide in confectionery sold in this state. The dealers who have not taken this stand will be prosecuted to the limit of the law.

[40] The viscosity is here measured directly in degrees of angular deflection, and is produced by the torque exerted upon a steel wire supporting a disk suspended in the rotating liquid. See Herschel, *J. Ind. Eng. Chem.*, vol. 12 (1920), p. 282.

[41] The final criterion for "grade" must be the strength of the glue in service. For the consideration of this phase of the subject see Part V.

[42] A discussion of the causes of variation in melting point will be presented in Part III.

[43] From considerations developed in Part V a temperature of about 90 deg. F., or 32 deg. C., is recommended.

[44] A 65 per cent solution of cane sugar at 90 deg. F. answers very well.

The Problem of the World's Supply of Energy*

Early Exhaustion of Fossil Fuels Will Require Use of Other Sources; Water, Wind and Sun Power. Continual Increase of CO_2 in Atmosphere Will Reforestate Temperate Zones and Drive Civilization Back to Its Birthplace: Mesopotamia, the Mediterranean, Central America and Peru

BY SVANTE ARRHENIUS, PH.D., M.D., D.SC., LL.D.

SINCE the days of Watt the physical well-being of mankind has become more and more dependent on fossil fuels. The life of today would be impossible without the enormous supply of coal necessary to industrial establishments, for railways and steamships, in the metallurgical arts and for the heating and lighting of our houses. The demand for fossil coal has increased very rapidly, about doubling every ten years during the last century, and is now some 1,200 millions of metric tons per year. It is clear to those who have studied the matter that our coal fields will be exhausted after a certain time. When this calamity will happen, and the probability of the discovery of substitute sources of energy are questions of vital importance.

ESTIMATED LIFE OF COAL FIELDS

One of these questions was answered by the Geological Congress in Canada in 1913. The quantity of fossil coal down to a depth of 1,800 m. would suffice for 6,000 years, at the present rate of consumption, if it were all recoverable, but a very great deal of this coal occurs in beds too thin for profitable working, a considerable part is lost as dust, or left in the mines as pillars, and further, the use of coal will probably increase in the future just as it has done in the past. It is, therefore, necessary to reduce the indicated time considerably, probably to one-fourth, or about 1,500 years.

Of the different countries the United States, in the matter of coal, has the best position, as it has in the matter of other natural resources. The coal treasures there will probably suffice for about two thousand years. The worst situation among the great coal-producing countries is that of England, where the coals will be exhausted within a little less than two hundred years. Germany will be able to meet its demands during a little more than a thousand years.

This time of some few hundreds or thousands of years is very short compared with the time estimate made at the Geological Congress referred to, and only about 1 per cent of the period of man's existence, which probably lies between the thousandth and ten-thousandth part of the time during which life has existed on our earth. It is quite clear that we must soon ration our coal, and substitute as far as possible for fossil fuel other sources of energy.

SUBSTITUTION BY MINERAL OILS IMPROBABLE

It is often suggested that we might use mineral oils as fuel instead of coals. This advice rather reminds one of the words of Marie Antoinette: "If the people complain that they have no bread to eat, why do they not eat cakes." Petroleum is a far more valuable fuel than coal, because it is much easier to transport and to use effectively. The world's yearly production of mineral oils represents not quite 3 per cent of the energy contained in the yearly production of coal. Petroleum ought, therefore, to be reserved for better purposes, e.g., production of light and lubricants. Further, the recent failure of many oil fields indicates that we must economize this valuable material. According to David T. Day, U. S. Geological Survey, the production per well in the Appalachian oil field decreased from 207 barrels in 1861 to 1.73 barrels in 1907. The production of West Virginia had, in 1910, declined 56 per cent from its maximum output. The oil obtained from the New York and Pennsylvania oil fields fell to 50 per cent from the year 1891 to 1898. If we suppose the present fields of the United States and the present rate of exploration should continue, petroleum would be exhausted by about 1935, and if the present production goes on with no increase, the product would be exhausted in about ninety years, said Charles R. van Hise in 1910, who has done so much to warn against waste in the expenditure of our natural resources. The output of mineral oil has been kept up through an enormous increase in the number of oil wells in each field, and by opening up new fields, e.g., in Oklahoma and California. There are very rich new oil fields in the world which are still not used, or only in a small degree, e.g., in Mexico and Mesopotamia and Turkestan, but certainly they will not last as long as the coal fields, even if the production of this fuel is restrained to but 3 per cent of the simultaneous production of the latter.

Still much less is the hope that sources of natural gas may deliver more than a small fraction of the fuel value of the oil fields. Even peat, although an important fuel, can by no means compete with coal. Thus, for instance, in the United States the available peat is less than one-half of one per cent of the estimated coal. Probably the relative value of the European peat bogs is about the same as compared with the European coal fields. For heating purposes petroleum and peat cannot play an important rôle as compared with fossil coal.

WATER POWER AS SUBSTITUTE FOR COAL

It is very often said that for coal should be substituted the water power of our rivers, often called the "white coal." According to an estimate of Engler, the energy which might be economically taken out from these waterfalls amounts to about 60 per cent of the energy of the present output of coal. But even this figure seems too high, for many of the waterfalls are located in rather inaccessible parts of the world, where no industry is likely to be developed for a long time. So it seems wise to reduce the figure of Engler about 50 per cent. If this is done, it is evident that there is little hope that white coal will be able to substitute for black, except in a small degree. For heating purposes water power

*Delivered through Dr. Allerton S. Cushman in Philadelphia, May 19, 1920, on being awarded the Franklin Medal by the Franklin Institute.

will probably not be used in a noteworthy degree, because used directly for the production of mechanical or electrical energy it is at least three times as valuable as the equivalent quantity of heat. Further, the well-situated waterfalls are already developed in greatest part, at least, in Europe. Thus, for instance, in Switzerland nearly all the waterfalls which have a commercial value are developed, and in a little less degree the same is true in all the other industrial countries of Europe.

Estimated Water Power Resources

During the unhappy situation created by the World War, when there was a great scarcity of fuel, and even now, when fuel is extremely expensive, waterfalls were and rapidly are being put to use. Within a short time, therefore, this source of energy will be taken into the service of man, not sensibly diminishing the demand for coal. An estimate of the power of the waterfalls has been made by Koehn and by Keplan, and is of much interest. Although the figures are only approximate, I give them in the accompanying table, with some later corrections. The power is given in millions of horsepower and horsepower per inhabitant:

TABLE. WATER POWER RESOURCES OF THE WORLD

Country:	Hp. in Millions	Hp. per Inhabitant
Asia	236	0.27
Africa	160	1.14
North America	160	1.17
South America	94	5.25
Europe	65	0.13
Australia	30	3.75
Total	745	Average 0.45
Canada	26	4
United States	100	1
Iceland	2	22
Norway	13	5.2
Sweden	6.7	1.2
Finland	2.6	0.8
Balkan Countries	10	0.6
Switzerland	1.5	0.4
Spain	5.2	0.26
Italy	5.5	0.15
France	6.0	0.15
Austria-Hungary	6.2	0.12
Germany	1.43	0.02
Great Britain	1.0	0.02
Russia	3.0	0.02

These figures are not altogether reliable. Thus, for instance, Leighton gives for the United States 200 millions, and van Hise says: "Others regard this estimate as too high, and say 100 million horsepower is nearer to truth." I think this latter figure is more to be depended on. Van Hise is of the opinion that even it will meet the needs of a population of 250,000,000. Since his estimate made in 1910 the demands for power have greatly increased, and probably only about one-half of the energy given in the table above is available at present without excessive initial expenditures. We may, therefore, assume 0.5 hp. per inhabitant as adequate to present needs. We find then that Europe and Asia are the only parts of the world where water power is really scanty—in Asia the demand is still so small that even this power per inhabitant is more than sufficient. Especially fortunate are those countries, such as South American Republics, and Australia, where water power per unit of population is well beyond this figure, and may be developed at a moderate cost. The United States is among the great powers very well endowed in this regard, as in most other natural sources of wealth, such as metal, ores and coal. In Europe, Iceland ranks first, because of its small population, and the old Saga Island may yet know a new and flourishing era. Then come the Scandinavian countries, the first being Norway, which has already greatly profited through its cheap power, and is destined to be one of the leading industrial countries of the future. Sweden and Finland possess enough power for their needs. Their waterfalls are not high, and in general are far from established lines of communication, especially from those of the ocean. Denmark has scarcely any water power, as also Holland. Among the other countries of Europe the Balkan States have more power than their industrial needs require. Switzerland may also be regarded as having a nearly sufficient supply of water power, which is the more fortunate, as this highly industrial country does not own any coal deposits. The same is true of the new Austria, which has lost its old coal districts but has retained by far the greater part of the waterfalls of the old Austria, so that it now probably ranks with Switzerland in this respect. Spain is also a relatively well situated state, but which up to the present has not made much use of its resources. In general, the waterfalls in the Alps, Spain, Italy and the Balkans are high and of great value. For the industries of France and Italy water power is of the greatest importance, although it must be regarded as insufficient for nations so highly developed. At the end of the list come the three great powers of Great Britain, Germany and Russia, with only a fiftieth horsepower per inhabitant. Russia is an agricultural country, with a very small demand for power, and agriculture will probably remain its chief industry because of its small power resources, both in coal and water. England and Germany, now the most highly developed industrial countries in the world, will undoubtedly also, in the future have agriculture for their chief industry. Probably a great part of these countries will again be covered by forests, as they were in the time of Tacitus.

It is often asserted that the power of tidal waves should be utilized. Of course, this is possible, but doing so on a large scale would involve an initial investment not justified by prices likely ever to be obtained for power. The energy of the tidal wave is so widely distributed along the shores of the oceans that it is impossible to commercially collect a sensible part of it. It is quite in contrast to the energy of fossil fuel and waterfalls.

Solar Energy Accumulated in Plants

All available energy on the earth has its origin in solar radiation. Of this energy a small part, 0.12 per cent, is accumulated in vegetation, which, however, is great as compared with the energy of the coal burned in the industries. A detailed calculation, made by Prof. Schroeder, of Kiel, shows that about twenty-two times as much energy is yearly accumulated in plants as is represented by the coal consumed in the same time. Of this energy in vegetation 67 per cent is taken up by the forests, 24 per cent in cultivated plants, 7 per cent in the grass of the steppes and 2 per cent on desert lands. The energy collected by forests may be used for heating purposes, and exceeds every year that of the coals burnt by about fourteen times. But, unhappily, the greater part of this energy is collected in tropical areas, and the highly cultivated countries are so nearly deforested that their production of wood is not nearly sufficient as fuel for their industries. Further, the wood produced in civilized countries is needed for the production of paper, pulp and lumber. In forest lands the refuse from the woods may be sufficient for domestic purposes, and during the war even the industrial needs of certain countries for combustibles were met by wood, where the importation of coal was hindered by the

blockade. The costs, however, were very high, due to the expensive transport from the forests to the industrial centers. The transport of wood from the immense forests in the tropics to industrial countries seems impossible on economic grounds. The forest lands possess, therefore, an advantageous position in this regard. Before other industrialized countries will be able to substitute wood for coal an economic solution of the transportation problem is necessary, which at present seems fraught with exceedingly great difficulties.

Power From Windmills

Two other sources of energy, greatly dispersed in form, remain to be considered, namely, those of the winds and of sunshine. They are extremely great, and exceed that of simultaneous burnt coal from 5,000 to 70,000 times, respectively. The energy of the winds is taken up by windmills, which have been in use in Europe since the eleventh century. The great objection to wind as a source of power is its variability, and the high installation costs per unit of power continuously deliverable. It has been proposed to store the energy of the wind by means of accumulators, charged from windmills, and to use these accumulators during times of calm. But even in windy countries, e.g., Denmark, this method is extremely uneconomical, as compared with coal or wood at their present price. Windmills are widely used for pumping water, both in the New and the Old World.

Solar Energy

The radiation of the sun may be concentrated by means of mirrors on a boiler, and this connected to a steam engine. The best known of these solar engines was constructed by John Ericsson, and described in *Nature* in 1888. It was an improvement of an earlier machine constructed in 1860. In his experiments in New York, John Ericsson obtained an effect of one horsepower with a mirror of 10 sq.m. opening. Later, his experiments were taken up on a commercial scale by Mr. Shuman, of Philadelphia, who installed a solar engine, with mirror of 1,200 sq.m. in all, at Meads, 10 km. south of Cairo, in Egypt. The machine was of the Ericsson type, with some small modifications, and auxiliary apparatus. Shuman did not obtain more than half the effect of that obtained by Ericsson, namely 1 hp. per 20 sq.m. mirror opening. After an inspection of Mr. Shuman's plant, Mr. Ackerman thought it possible to introduce improvements which would give as good results as those obtained by Ericsson.

Future of Solar Engines

After improvements the solar engine seems likely to play an important rôle in the opening up for cultivation of great arid districts in tropical countries, as Ericsson maintained with great energy it would do. In these parts of the world are great deserts, such as Sahara, the Arabian desert, the Syrian desert, and those in Mesopotamia, which have in historical times been the seat of flourishing culture, but are now the home of wandering tribes. The decay of these regions resulted from the destruction of their aqueducts and irrigation plants, which the present wandering population is unable to restore. With the aid of the solar machine it would be possible to re-establish the old agriculture and horticulture of these districts, and industrial works founded on its use might also be looked forward to. It is not only in the deserts that the sun in shining nearly continuously during the greatest part of the year, but extensive provinces in Spain, Greece and North America possess such a climate that they would profit by the introduction of the solar engine. In other parts of the world, where the sky is covered for the greatest part of the year, as in the Congo or the Amazons, or which lie nearer to the poles, as the temperate regions, the solar machine will be of very little use.

Probable Results of Total Consumption of Coal

It seems very probable that when fossil fuel has been consumed, civilization and culture will return to its birthplace about the Mediterranean and in Mesopotamia in the Old World, and to Central America and the land of the Incas in the new.

According to some calculations made by me an increase of the carbonic acid in the atmosphere will give the whole earth a more uniform and warmer climate. Therefore, we may suppose that the burning of coal will cause our climate to approach to that of the tertiary age. Furthermore, vegetation is highly stimulated through absorption of carbonic acid in the soil, augmented through an increase of the carbonic acid in the air. It is, therefore, probable, as I have tried to show in my book, "World's in the Making," that the total consumption of the available coal by the industries will, in a high degree, favor agriculture and the growing of forests in the temperate regions now the chief seat of culture. These regions will then know not only harmful, but some useful consequences as the result of the present waste of our fuel resources.

Stockholm, Nobel Institute.

Thermo-Electricity Progress

Prof. C. A. F. Benedicks, of Stockholm University, delivered a lecture on "Recent Progress in Thermo-Electricity" before the Institute of Metals, June 10, 1920. He first gave a short summary of his theoretical views upon the metallic conduction of electricity which explained many matters not made clear by the former electron theory. A consequence of this new theory was that one has to conclude that even in a single homogeneous metal thermo-electric currents do occur; hitherto such currents were believed to be produced only when two different metals were present. Prof. Benedicks gave a concise demonstration of the most important experimental evidence of the truth of this conclusion, utilizing for this purpose various metals.

In liquid mercury it had been possible for him definitely to prove the existence of thermo-electric currents, thus disproving the negative results of previous workers. A consequence of what the lecturer termed his "homogeneous *thermo-electric* effect" was that there must exist the *reverse* effect, the "homogeneous *electro-thermic* effect," including as a special case the well-known Thomson effect. The reality of this effect was duly made clear. A specially interesting demonstration was of a new rotating thermo-electric apparatus made entirely of copper and rotating in a magnetic field, the driving force originating solely from unequal heating (by means of a tiny gas jet) of thin strips of copper.

The point at which the new knowledge brought forward by Prof. Benedicks might have some practical interest lay in the possibility of reducing the thermal conductivity of metals by insulated subdivision into fine wires without impairing the electrical conductivity. The demonstrations were carried out with the aid of a galvanometer provided by the Cambridge & Paul Instrument Co.

Characteristics of Primary Low-Temperature Tar

By Franz Fischer*

IT IS desirable to have an easy method of distinguishing light, primary tar from ordinary tar. Today many wholly useless products are given out as genuine primary tar which in reality have nothing to do with the true low-temperature tar. It is possible, however, that with the characteristics of this tar which we now give, not all of the numerous points of difference are established finally, through which a high-grade primary tar passes from a useless, thick, pitch-like, ordinary tar of the vertical retorts, generators, cokeries and ovens. It is possible too, that a further definition of the given conditions for primary tar may be necessary.

The following characteristics must be required of a good quality of the genuine tar in general:

1. It must be liquid at room temperature; at the most a separation of small amounts of paraffine may influence its ready fluidity.
2. Its specific gravity at 25 deg. C. must correspond to 0.95-1.06.
3. On a thin layer it is a golden red to port wine colored oil.
4. In the fresh state it smells nearly always of sulphuretted hydrogen or sulphide of ammonium. In no case should it smell of naphthalene.

Naphthalene Test

Low-temperature tar, if rightly prepared at moderate temperatures, contains no naphthalene. Naphthalene is a secondary product obtained first at 750 deg. C. and above. A tar, therefore, which contains naphthalene has been heated to a higher temperature than that employed for the production of primary tar. The simplest method of distinguishing them is based upon these facts. At the high temperature at which naphthalene is obtained primary tar is altered in constitution. It contains, as we know, among its constituents paraffine, olefines, naphthalene, phenols, and, only in small proportion, aromatic hydrocarbons. To the first four constituents it owes its low specific gravity, and these four constituents are converted at temperatures higher than 550 deg. C., in great measure, into aromatic compounds by which a rise in specific gravity is caused. Upon these facts is grounded a second method of distinguishing primary tar from ordinary tar.

Thickening Power

If naphthalene is not found, a finer method is required. On the one hand, naphthalene-free tar is not always primary tar, since overheating is not always carried to such a degree that naphthalene is formed; then a naphthalene-free tar may be overheated. A process to distinguish between them is based upon the solubility power of the individual constituents of the tar and their specific gravity.

The hydrocarbons afford a suitable means of following this process, since the phenols are not adapted for the purpose, because the quantity of phenols in the tar is subject to great variations, according to the kind of coal used. We propose, in the next place, to shake up the tar in petroleum spirit, and then separate the pitch and asphalt constituents; the petroleum spirit solution is then freed from acid compounds by alkali and distilled at 200 deg. C. The oil which goes over at temperatures from 200 to 300 deg. C. is separated and taken up, and from the distillate and residue the specific gravity is determined. With primary tar the distillate of 200-300 deg. C. is below 0.90 at 20 deg. C. With other tars, it is nearly 1 or over. The residue obtained by boiling at 300 deg. C., is, in the case of primary tar, thick, like paste, owing to the separation of paraffine; it is completely soluble in petroleum spirit and ether, and at 50 deg. C. has a specific gravity below 1. The residue obtained in a similar manner by boiling overheated tar at 300 deg. C. dissolves, after distillation of the 200-300 fractions, only partially in cold petroleum spirit, leaving a residue of solid matter. This residue, also, is not completely soluble in ether, and has at 50 deg. C. a specific gravity of over 1—that is, it sinks in water at 50 deg. C.

Sampling

Technical primary tar to the amount of 300 c.c. was thoroughly shaken in a flask for several minutes with 300 c.c. of petroleum spirit. The brownish-yellow red solution was then poured off from the separated dark viscous mass, and shaken up with 200 c.c. of 5N (20 per cent) soda lye in a glass arm. The soda lye was then drawn off, replaced by an equal quantity of fresh lye, shaken up again, and separated. The petroleum ether solution was washed with an equal quantity of water and separated. To remove all traces of water, it was filtered, the petroleum spirit evaporated from a small flask over the water bath until no more went over. The residue was then freed from all fractions boiling at 200 deg. C. or over, in a flask over an asbestos plate, and after filling up a still smaller flask of about 100 c.c. capacity, it was distilled off in a flame at 300 deg. C. The distillate of 200-300 deg. C. then corresponded to about 20 per cent of the residue.

The values thus obtained are given in the following table:

	Technical Tar	Vertical Retort Tar	Mond's Gas Tar
Sp.gr. (20 deg. C.) of fraction 200-300...	0.9700	0.9850	0.9306
Sp.gr. (50 deg. C.) of the residue boiling above 300 deg. C.....	0.9606	1.0931	0.9713

The residues obtained by distillation of the primary tar and Mond's or oven gas tar were thickened to a soapy character by separation of the paraffine. Both were readily dissolved in ether and petroleum spirit in the cold. By rubbing up a sample with an equal volume of acetone the paraffine could be separated in the form of white flakes. The residue of vertical retort tar showed, in comparison with primary tar, a quite minimal separation of paraffine in the form of a thin film and left behind after rubbing up with petroleum spirit the greater part of its substance in the form of a brown, insoluble mass. Ether left a very dark, flocculent mass undissolved.

We examined such a product. The sample failed to show the characteristics No. 3, as the tar remained wholly black. But the naphthalene test showed that it contained no naphthalene. Specific gravity, however, proved that it belonged to primary tar, in which only the lower fractions were wanting.

A sample was obtained from a Breslau gas works. Externally this tar resembled a good quality of primary tar, showed a relatively great fluidity, no smell of naphthalene and the golden red so characteristic of primary tar. But the sp.gr. of 1.084 distinguished it from primary tar as did the positive naphthalene test, its behavior to petroleum spirit.

*Translated from *Zeitschrift für angewandte Chemie*, 1920.

Permeability of Rubber to Gases—II

Relative Permeabilities to Hydrogen of Oxygen, Nitrogen, Argon, Air, Carbon Dioxide, Helium, Ammonia, Ethyl Chloride, Methyl Chloride and Water Vapor—Factors Summarized and Data Tabulated*

By Junius D. Edwards and S. F. Pickering

On determining the permeability of rubber to different gases it is preferable to refer the values to some standard rather than attempt to express the permeability in absolute units. In this work, the permeability to hydrogen has been adopted as the standard rate because hydrogen is so generally used for filling balloon envelopes and because the greatest part of our knowledge of the permeability of rubber to gases concerns hydrogen. Accordingly, the permeability to hydrogen of any sample of rubber has been set equal to unity; its permeability to any other gas is given as the ratio of its permeability to that gas to its permeability to hydrogen. In order to secure the required precision it has been necessary to determine the permeability of every test piece, both to hydrogen and to the gas in question.

The hydrogen used in all this work was made in a Kipp generator from a very pure lot of zinc and from c.p. hydrochloric acid. It was purified by passage over soda-lime and anhydrous granular calcium chloride. Conclusive tests made in another connection, on hydrogen generated in this way, showed it to contain not more than 3 or 4 parts in 10,000 of impurity when the generator was properly swept out.[7]

It was found that the ratio of permeabilities for different gases with different samples of rubber was fairly constant—sufficiently so to make the results of interest and value. In all probability the ratio varies somewhat with different samples of rubber; the extent of this variation is indicated roughly by the concordance of the results secured with different samples. In a preceding section a first approximation to the specific permeability of rubber to hydrogen was given; this value multiplied by the ratio of permeabilities of different gases will give approximately the specific permeabilities of those gases.

Permeability of Rubber to Oxygen

It is an interesting fact, first pointed out by Graham, that rubber is more permeable to oxygen than to nitrogen. As a result, air which has passed through rubber contains a higher percentage of oxygen than normal air. The significance of this fact in connection with the use of rubber-coated balloon fabrics has already been discussed by one of us.[8]

The permeability of rubber to oxygen was determined with the apparatus of Fig. 1 with some appropriate minor changes. A current of oxygen was passed over one side of the fabric and hydrogen over the other side. The oxygen passing into the hydrogen was determined with the interferometer, using hydrogen from the same source as the standard of comparison. The oxygen was analyzed volumetrically. The results were corrected to a partial pressure of 100 per cent; the existing partial pressure of oxygen was 99.55 per cent.

The results of a series of tests are shown in Table I. The average ratio of permeabilities, oxygen to hydrogen, is about 0.45. For this ratio Graham found the value 0.466 and Dewar's[9] curves show a value of 0.500 at 25 deg. C.

TABLE I. PERMEABILITY OF RUBBER TO OXYGEN AND HYDROGEN

Fabric No.	Permeability to Oxygen Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Oxygen: Hydrogen
50,313	5.09	11.83	0.430
50,313	5.16	11.91	0.433
50,313	4.84	10.81	0.448
50,313	4.97	10.77	0.461
50,313	4.82	11.06	0.435
50,313	5.30	11.52	0.460
Average			0.445

Permeability of Rubber to Nitrogen

The permeability of rubber to nitrogen was determined in the same way as the permeability to oxygen except that nitrogen was used in place of oxygen. The results of these experiments are given in Table II: the average ratio of permeabilities, nitrogen: hydrogen is 0.16. Graham[10] gives the value 0.18 and Dewar's[11] value is 0.12 (at 15 deg. C.).

TABLE II. PERMEABILITY OF RUBBER TO NITROGEN AND HYDROGEN

Fabric No.	Permeability to Nitrogen Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Nitrogen: Hydrogen
50,313	1.48	8.77	0.169
50,313	1.53	9.47	0.162
50,313	1.45	9.14	0.159
50,313	1.38	9.10	0.152
50,313	1.51	8.76	0.172
50,313	1.27	9.08	0.140
50,313	1.44	9.41	0.153
50,313	1.52	8.73	0.174
Average			0.160

Permeability of Rubber to Argon

No experiments with argon were made in the course of the present work because a satisfactory sample of argon was not available. For the sake of completeness, reference will be made to the work of Dewar[12] and of Rayleigh[13] with argon. Dewar found the ratio of the permeabilities to argon and to hydrogen to be $\frac{1.28}{15.6} = 0.23$ at 15 deg. C. Rayleigh found that in a sample of "air" which had diffused through rubber there was 1.93 per cent argon in the nitrogen after removing

*This paper, of which part I was published in Chem & Met. Eng., vol. 23, No. 1, July 7, 1920, is a condensation of a comprehensive report to be issued by the U. S. Bureau of Standards.

[7]Edwards, "Preparation and Testing of Hydrogen of High Purity," *J. Ind. Eng. Chem.*, vol. 11, p. 961; 1919.

[8]Edwards and Ledig, "Significance of Oxygen in Balloon Gas," *Aviation and Aeronautical Eng.*, vol. 6, p. 325; 1919.

[9]*Proc. Roy. Inst.*, vol. 21, p. 813; 1915.

[10]*Loc. cit.*

[11]*Loc. cit.*

[12]*Loc. cit.*

[13]*Phil. Mag.*, vol. 49, p. 220; 1900.

the oxygen. Atmospheric nitrogen contains $\frac{0.94}{78.12} = 1.20$ per cent argon. He therefore concluded that rubber was somewhat more permeable to argon than to nitrogen. The ratio of permeabilities, argon : nitrogen, calculated from his original data is 1.6. Using the value we have found for the ratio nitrogen : hydrogen, the ratio argon : hydrogen would be 0.26.

Permeability of Rubber to Air

The permeability of rubber to air can be calculated from its permeability to oxygen and nitrogen by means of the proportionality between permeability and partial pressure. According to Sir William Ramsay the composition of air is as follows: Nitrogen, 78.12 per cent; oxygen, 20.94 per cent, and argon, 0.94 per cent. The permeability of rubber to air (referred to hydrogen) would then be

$$P = (0.7812 \times 0.16) + (0.2094 \times 0.45) + (0.0094 \times 0.26) = 0.22$$

In confirmation of this value, the permeability to air was determined directly by the same method used in the case of oxygen and nitrogen. The refractivity of the air which had diffused through the rubber was calculated from the composition as determined by typical analyses. The influence of any probable variation in composition is negligible. The results are given in Table III. Though the data are few in number and not very concordant, the average ratio, 0.23, is in close agreement with the value (0.22) which was just calculated.

TABLE III. PERMEABILITY OF RUBBER TO AIR AND HYDROGEN

Fabric No.	Permeability to Air Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Air : Hydrogen
50,313	2.21	9.45	0.234
50,313	2.14	8.73	0.245
50,313	1.97	9.40	0.210
Average			0.230

The composition of air which has diffused through rubber is a matter of interest. This may be calculated from the permeability to nitrogen, oxygen and argon and their partial pressures. The composition thus calculated is as follows:

	Per Cent		Per Cent
Nitrogen	56.8	Argon	0.9
Oxygen	42.3		
			100.0

Graham found as much as 41.6 per cent oxygen in air which had diffused through rubber; Edwards and Ledig[14] found 41 per cent.

These facts are of obvious practical importance in many instances.

Permeability of Rubber to Carbon Dioxide

In determining the permeability to carbon dioxide, the regular method with the interferometer was employed. The carbon dioxide was generated from marble and hydrochloric acid and passed over anhydrous sodium carbonate and calcium chloride. Volumetric analysis showed the presence of 99.9 per cent carbon dioxide. The results of a series of these tests are shown in Table IV. Each permeability value recorded in the table is the average of three to six separate observations on the same test piece.

[14] "Significance of Oxygen in Balloon Gas," *Aviation and Aeronautical Eng.*, vol. 6, p. 325; 1919.

TABLE IV. PERMEABILITY OF RUBBER TO CARBON DIOXIDE AND HYDROGEN

Fabric No.	Permeability to Carbon Dioxide Liters per sq.m. per 24 Hr.	Permeability to Hydrogen Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Carbon Dioxide : Hydrogen
50,313	27.3	9.6	2.84
50,313	28.6	9.7	2.95
Dental dam	42.4	14.0	3.03
26,293	27.0	9.2	2.94
26,293	26.6	9.5	2.80
Average			2.91

The values obtained for the permeability of fabric No. 50,313 to hydrogen and carbon dioxide in the partial pressure experiments recorded in a previous section may be used to obtain a value for this ratio, even though the determinations with hydrogen and carbon dioxide were not made with the same test pieces. The average of seven determinations with hydrogen was 9.71 liters and the average of seven determinations with carbon dioxide was 27.86; the ratio is 2.87, which is in substantial agreement with the ratio 2.91 found in Table IV. It may be concluded that rubber is approximately 2.9 times as permeable to carbon dioxide as to hydrogen.

Values found by other experimenters for this ratio are of interest. Graham[15] gives 2.47 as the ratio (temperature not specified). Kayser[16] gives equations for the variation of permeability with temperature; the ratio of the permeabilities of rubber to carbon dioxide and hydrogen at 25 deg. C., as calculated from these equations, is 2.48. Dewar,[17] using thin films of rubber under tension and having a thickness of about 0.01 mm., found a value of 2.5 for this ratio at 15 deg. C. In another series of experiments at "ordinary temperatures" Dewar found, for the same film, a relative rate of $\frac{30.0}{8.4} = 2.8$.[18]

Permeability of Rubber to Helium

A knowledge of the permeability of rubber to helium is of great importance at the present time because of the recent development by the U. S. Government of a supply of helium for filling airships. The investigation of the permeability of balloon fabrics to helium was made for the Bureau of Steam Engineering of the Navy Department. The helium employed was furnished by that Bureau and was contained in a steel cylinder under 1,800-lb. pressure. Its composition, as determined by our analysis, was as follows:

	Per Cent		Per Cent
Helium	94.6	Methane	0.2
Nitrogen	5.2		
			100.0

The methane in the gas was determined by combustion with oxygen. The density of the gas was then determined with the Edwards gas density balance and the composition calculated on the assumption that the residue was nitrogen and helium. Oxygen was tested for and shown to be absent. To confirm the analysis a direct determination of nitrogen was made by absorption with metallic calcium. This method showed approximately 5 per cent nitrogen. When the gas was examined spectroscopically, neon and argon were found to be either absent or present in such small amounts as to be masked by the other gases present. Accordingly, it is thought that no appreciable error was

[15] *Phil. Mag.*, vol. 32, p. 401; 1866.
[16] *Wied. Ann.*, vol. 43, p. 544; 1891.
[17] *Proc. Roy. Inst.*, vol. 21, p. 813; 1915.
[18] *Proc. Roy. Inst.*, vol. 21, p. 559; 1915.

introduced by the assumption that the residue consisted of helium and nitrogen. The refractivity of the mixture as determined with a Zeiss-Rayleigh interferometer indicated an amount of helium within 0.3 per cent of the value shown by the above analysis.

The amount of helium penetrating the fabric was determined with the interferometer in the usual way. Because of the large difference in the refractivities of air and helium, $(2917 - 342) \times 10^{-7}$, the interferometer furnished a very sensitive means of determining helium. Each scale division indicated about 0.004 per cent helium in air; the total amount present could be determined with that precision.

The observed permeability obtained with the gas containing 94.6 per cent helium was corrected to the standard condition; that is, a difference in partial pressure of 100 per cent helium on the two sides of the fabric. This was done by multiplying the observed permeability by the ratio $\frac{100}{94.6 - x}$ where x is the percentage of helium (usually about 0.4 per cent) on the "air side" of the fabric.

In Table V are given the permeabilities to helium and hydrogen of a number of samples of different fabrics. The fabrics tested are from three different manufacturers and include both envelope and ballonet fabrics. Although there was considerable variation in the relative permeabilities, this variation could not be entirely ascribed to experimental error. It seems probable that part of this variation is due to differences

TABLE V. PERMEABILITY OF RUBBER TO HELIUM AND HYDROGEN

Fabric No.	Observed Permeability to Helium Liters per sq. m. per 24 hr.	Permeability Corrected for 100% Helium Liters per sq. m. per 24 hr.	Observed Permeability to Hydrogen Liters per sq. m. per 24 hr.	Ratio of Permeabilities Helium : Hydrogen
27,145	9.6	10.2	16.1	0.63
45,847	9.8	10.3	15.7	0.66
45,835	7.6	8.0	14.0	0.57
45,838	7.4	7.9	13.7	0.58
36,827	6.4	6.8	10.0	0.68
36,827	6.7	7.0	10.6	0.66
36,827	6.5	6.9	10.7	0.64
36,827	6.2	6.6	10.0	0.66
36,827	6.6	7.0	10.6	0.66
36,827	6.1	6.4	9.5	0.67
36,827	6.3	6.7	9.3	0.72
36,827	6.5	6.9	9.4	0.73
26,293	5.7	6.1	9.8	0.62
24,579	4.8	5.1	8.7	0.59
Average				0.65

in the relative permeabilities of different fabrics to these gases. The average ratio of 0.65 appears satisfactory for present purposes.

The other values for this ratio which appear in the literature are those of Dewar[19] and Barr[20]. Dewar found a ratio of $\frac{1.75}{5.6} = 0.31$.

No information is given regarding the helium used. Barr estimated two-thirds of the permeability to hydrogen—a value which is in agreement with ours.

Permeability of Rubber to Ammonia

Ammonia has been considered as a filling gas for balloons. Its specific gravity is only 0.596 and it offers advantages from the standpoint of freedom from fire hazard and the fact that it can be transported in the liquid form. However, the fact that rubber is quite permeable to ammonia would necessitate the use of a different type of fabric for the balloon envelope.

In determining the permeability of rubber to ammonia it was necessary to use a special permeability cell made of steel, which would be unattacked by the ammonia. All connecting tubes coming in contact with the ammonia were either steel or glass. The ammonia which passed through the fabric into the air stream was absorbed in a measured volume of tenth-normal sulphuric acid and the excess acid determined by titration. Two small wash bottles were always used in series but never more than a negligible amount of ammonia escaped absorption in the first wash bottle. Two sets of wash bottles were used and they were connected to the cell alternately through a three-way cock. They were attached to the system by a mercury seal so that they could be easily detached. Each value recorded in the table is the average of a number of observations each covering a half-hour period.

TABLE VI. PERMEABILITY OF RUBBER TO AMMONIA AND HYDROGEN

Fabric No.	Permeability to Ammonia Liters per sq. m. per 24 Hr.		Permeability to Hydrogen Liters per sq. m. per 24 Hr.		Ratio of Permeabilities Ammonia : Hydrogen
50,313	71.9		9.0		7.99
	59.3	[a]			
	61.1	[a]			
50,313	71.8	73.0	9.1		8.02
	74.2				
50,313	80.0	80.4	10.0		8.04
	80.9				
Dental dam	119.6	119.7	15.4	15.1	7.93
	119.8		14.8		
Average					8.00

a These two results which were obtained on two succeeding days indicated that some change had occurred in the sample and they are omitted from the average.

The ammonia was taken from a small steel cylinder, which had been evacuated to a very low pressure before filling with liquid ammonia. The gas can be considered to be free from air and water vapor; in fact, the total amount of impurity in this sample, which was carefully purified by fractionation, was shown by tests of C. S. Taylor of this Bureau to be less than 1 part per 100,000. The results of a series of experiments is given in Table VI. The average ratio of the permeability to ammonia and hydrogen is probably very close to 8.0.

Permeability of Rubber to Ethyl Chloride

An interferometer of the portable type was used for determining the percentage of ethyl chloride passing through the fabric into the air stream. The ethyl chloride was contained in a glass flask fitted with a steel valve and the vapor could be readily withdrawn under its own pressure. It was prepared by C. S. Taylor of the Bureau of Standards, from very pure materials, and further purified by fractionation. The total impurity in the vapor phase was undoubtedly less than 1 part in 10,000, a purity far beyond that required for the present work.

TABLE VII. PERMEABILITY TO ETHYL CHLORIDE AND TO HYDROGEN

Fabric No.	Permeability to Ethyl Chloride Liters per sq. m. per 24 Hr.	Permeability to Hydrogen Liters per sq. m. per 24 Hr.	Ratio of Permeabilities Ethyl Chloride: Hydrogen
50,313	1,717	8.80	195
50,313	1,851	9.76	190
50,313	1,810	8.31	218
50,313	1,763	9.44	187
Average			198

[19] *Loc. cit.*
[20] Barr. British Advisory Comm. for Aeronautics, 1915.

The permeability of rubber to ethyl chloride, as shown by these few tests, is approximately 190 to 200 times its permeability to hydrogen.

Permeability of Rubber to Methyl Chloride

For the purpose of comparison with ethyl chloride, the permeability of rubber to methyl chloride (CH_3Cl) was also determined. The interferometer was employed in estimating the percentage of methyl chloride in the same maner as with ethyl chloride. The sample of methyl chloride used had been carefully purified by fractionation by C. S. Taylor. Three tests were also made with a sample of methyl chloride the purity of which was unknown. These gave a ratio of permeabilities, methyl chloride to hydrogen, of 16.8, 17.6 and 17.8, but they are not included in the average. The other results are given in Table VIII. The permeability of rubber to methyl chloride is approximately 18.5 times its permeability to hydrogen.

TABLE VIII. PERMEABILITY OF RUBBER TO METHYL CHLORIDE AND HYDROGEN

Fabric No.	Permeability to Methyl Chloride Liters per sq. m. per 24 Hr.	Permeability to Hydrogen Liters per sq. m. per 24 Hr.	Ratio of Permeabilities Methyl Chloride Hydrogen
50,313	173.8	9.43	18.4
50,313	185.8	9.58	19.4
50,313	174.8	9.68	18.1
50,313	180.3	9.86	18.3
Average			18.5

Permeability of Rubber to Water Vapor

The permeability of rubber to water vapor is interesting for a number of reasons. In view of the popular conception of rubber as a "waterproof" material it might be thought that it was quite impermeable to water vapor whereas the opposite is true—its permeability is relatively high. This fact is of great importance in many instances where rubber is used as a gas container, such as, for example, the use of rubber tubing in chemical and physical work. The use of rubber connections in any apparatus where the water content of the gas is important may introduce errors.

TABLE IX. PERMEABILITY OF RUBBER TO WATER VAPOR AND HYDROGEN

(Air Partially Saturated With Water Vapor in Contact With Rubber)

Sample No.	Permeability to Water Vapor (100 per Cent Partial Pressure.) Liters per sq.m. per 24 Hr.	Permeability to Hydrogen. Liters per sq.m. per 24 Hr.	Ratio of Permeabilities Water Vapor: Hydrogen
A 17 Thickness 0.18 mm.	953	.....	.....
	969	.....	.....
	1,270	.....	.....
	1,001	.....	.....
	1,108	.....	.....
	978	.....	.....
	1,130	.....	.....
	1,174	.....	.....
	975	.....	.....
	920	.....	.....
	1,021	.....	.....
	875	.....	.....
	970	.....	.....
	890	.....	.....
	1,030	.....	.....
	1,019	.....	.....
	1,262	.....	.....
	1,075	.....	.....
Average	1,034	22.0	47.0
A 19 Thickness 0.25 mm.	905	.....	.....
	905	.....	.....
	726	.....	.....
	1,118	.....	.....
	860	.....	.....
	765	.....	.....
	905	.....	.....
	930	.....	.....
Average	888	14.3	62.0

The high permeability of rubber to water vapor renders its determination rather difficult. The first method employed in its determination was to pass a current of air saturated with water vapor at a temperature slightly below 25 deg. C. over the fabric, which was maintained in the cell at 25 deg. C. A stream of air, previously dried over phosphorus pentoxide, was passed over the other face of the fabric and thence through an absorption tube filled with phosphorus pentoxide in which the water vapor could be absorbed and weighed. The results were very erratic, probably because of the low partial pressure of the water vapor in the air (about 3 per cent) and the large effect on the difference in partial pressure produced by small variations in the rate of passage of the dry air. The results, however, are confirmatory of those secured by the following method:

TABLE X. PERMEABILITY OF RUBBER TO WATER VAPOR

(Liquid in Contact With Rubber)

Sample No.	Permeability to Water Vapor, Liters per sq.m. per 24 Hr.	Permeability to Hydrogen. Liters per sq.m. per 24 Hr.	Ratio of Permeabilities. Water Vapor: Hydrogen
A-18 Thickness 0.21 mm.	1,526	.....	.....
	1,700	.....	.....
	1,846	.....	.....
	1,918	.....	.....
Average	1,748	18.4	95.0
A-19 Thickness 0.25 mm.	1,510	.....	.....
	1,752	.....	.....
	1,740	.....	.....
	1,581	.....	.....
	1,638	.....	.....
	1,712	.....	.....
	1,562	.....	.....
Average	1,642	14.3	115.0

A shallow crystallizing dish, 8 cm. in diameter, was partly filled with phosphorus pentoxide and the top closed by a sheet of rubber, such as dental dam, which was fastened at the edge with rubber cement. The dish was then placed in an atmosphere saturated with water vapor and the rate of increase in weight determined. The results are shown in Table IX; obviously, they only give an approximate figure and no claim of accuracy is made for them. Lack of time prevented carrying this phase of the work farther. In connection with this table and the succeeding one, attention should be called to the fact that the permeability to water vapor is calculated for the assumed case of a difference in partial pressure of water vapor of 760 mm. This is done to make the results comparable with the hydrogen value. In any test the partial pressure of water vapor was about 20 mm.

A few experiments were also made with liquid water in contact with the rubber film. In these tests, instead of cementing the rubber to the dish containing the phosphorus pentoxide, the rubber was cemented to the top of another exactly similar dish from which the bottom had been removed. The edges of both dishes were ground plane. The dish with the rubber film across the bottom was partially filled with water and placed on top of the dish containing the phosphorus pentoxide. When it was desired to weigh the lower dish, the upper dish was replaced by a watch glass. The results of these tests are shown in Table X. In calculating the results the partial pressure of water vapor used was that corresponding to the temperature of the water in contact with the rubber.

According to these few tests the permeability of rubber to water vapor is about fifty times the permeability to hydrogen when saturated air is in contact with the rubber and about 100 times when liquid water is in contact with the rubber. In these methods diffusion processes were depended on to bring the water vapor into contact with the rubber and from the rubber to the phosphorus pentoxide. This factor should tend to give low values. The accidental errors of handling and weighing would probably be in the opposite direction.

Theory of Permeability

One object of this investigation was to establish, if possible, a quantitative relationship between the permeability of a film of rubber to any particular gas and the various factors on which it is dependent. Only the part of the program detailed in the preceding pages was completed, however, before it became necessary to discontinue the work.

A simple and satisfactory picture of the process is one of dynamic equilibrium in which the gas is dissolved at one side of the rubber at a rate proportional to its solubility and partial pressure, and diffuses through the rubber where it evaporates from the other side. The same process takes place in the opposite direction so that the net transference of gas is proportional to the difference in the partial pressures at the two faces of the rubber. Because of the lack of data it is not feasible to analyze the relations between solubility and rate of diffusion through the rubber. The permeability in every case investigated increases rapidly with increase of temperature. According to Kayser[21] the solubility of both carbon dioxide and hydrogen decreases with increase of temperature. If this be true there must be a rapid decrease in the internal resistance of the rubber to the passage of the gas, because the ordinary temperature coefficient of gaseous diffusion is unable alone to account for the facts.

A rough parallel, with notable exceptions, may be drawn between the permeability of rubber to different gases and to the boiling points of the gases. In general, the higher the boiling point of the gas the greater the rate at which it penetrates rubber. The specific chemical characteristics of the gas and of the rubber colloid determine, however, the solubility, rate of penetration, etc., and not enough is known of them at the present time to warrant further speculation. There are, however, many interesting fields of investigation opened by this work, and the results should be extremely useful in the many cases where the behavior of rubber in contact with gases is concerned.

Summary

Certain of the factors which determine the permeability of rubber to gases have been investigated and the relative rates of penetration of a number of gases determined. The major findings are summarized as follows:

1. The permeability of rubber compounds varies with the composition as would be expected. The aging of rubber films is accompanied by a decrease in permeability; a similar decrease may be effected by over-vulcanization. The rubber, which shows a very low permeability for these reasons, is usually very much deteriorated and frequently brittle, so that it is a disadvantage from the standpoint of gas-tightness.

2. The permeability to any gas is found to be directly proportional to its partial pressure provided the total pressure is constant. The variation of permeability with total pressure depends on the thickness of the rubber, the way in which it is supported, etc.

3. The permeability to hydrogen is inversely proportional to the thickness of the rubber. No other gas was tested in this respect.

4. The specific permeability to hydrogen at 25 deg. C. of vulcanized rubber similar to the grade known as dental dam is about 20 $\times$ 10^{-8} c.c. per minute. This value varies somewhat with the age and chemical characteristics of the rubber.

5. The temperature coefficient of permeability is quite high. For example, in the tests at 100 deg. C. the permeability to carbon dioxide or helium was about seventeen times the rate at 0 deg. C.; the permeability to hydrogen was about twenty-two times as great at 100 deg. as at 0 deg. C.

6. The relative permeability of rubber to some common gases is shown in the following summary:

Gas	Relative Permeability Hydrogen = 1
Nitrogen	0.16
Air	0.22
Argon	0.26
Oxygen	0.45
Helium	0.65
Hydrogen	1.00
Carbon dioxide	2.9
Ammonia	8.0
Methyl chloride	18.5
Ethyl chloride	200.0

7. The permeability of rubber to water vapor is high—approximately fifty times the permeability to hydrogen. This value, not having been determined with any precision, is not included in the table above.

Acknowledgment

Special acknowledgment is due the Goodyear Tire & Rubber Co. for the samples of rubber and fabric furnished to us in the course of this work. Many of these were especially constructed to meet our specifications. The company's enthusiastic co-operation has been of great assistance.

[21] *Wied. Ann.*, vol. 43, p. 544, 1891.

Increasing Demand for Paints, Oils and Varnishes in South Manchuria

The erection of new buildings in connection with the development of South Manchuria should increase the importation of paints, oils, and varnishes, which have amounted to about $1,000,000 annually, approximately 60 per cent of which was used by the South Manchurian Railway Co. Prior to the war, British and American paints dominated this market, but as it became more difficult to obtain the desired brands, because of the lack of shipping facilities, those of Japanese manufacture became better known. With the return of normal conditions the potentialities of this market have become greater, providing American makes can compete with the prevailing prices, as their superior quality is recognized. One of the brands now in demand is an ordinary lead paint, packed in drums of 28 and 112 lb., the former selling at $2.50 and the latter at $4.50. Mixed paints, put up in 1-lb. tins, sell wholesale at $1.50 per dozen tins. Enamels, which are now in great demand, wholesale at $3.50 per dozen tins of ½ lb. each. Varnish is selling at $4.20 per dozen tins of 2 lb. each. There are two kinds of paint oil on the market, one reported to be of pre-war stock is put up in 4-gal. drums, selling at $7 per drum wholesale; and the other, a Japanese product, put up in 36-lb. drums, selling at $4 per drum.

Synopsis of Recent Chemical & Metallurgical Literature

Slag Brick.—A. GUTTMANN, in an article in *Stahl und Eisen* for March 4, describes Schol's process of making slag brick of high heat resistivity in use at the Oberscheld iron works. Here an iron furnace slag containing about 35 per cent SiO_2 and not less than 44 per cent CaO is pushed horizontally into a shallow pool, so as to be transformed into an almost frothy material called "thermosit," with a density of 0.3 and thermal conductivity of 0.07. The thermosit is screened and the grains of half an inch size and less are mixed with a certain proportion of a binding agent, prepared from fine slag sand and unslaked lime; the lime is slaked and the dried mixture is ground. One part of this slag-cement and six parts of the thermosit, together with water, are then introduced into a drum, from which they enter the brick press, in which pressure is applied first from the top and then from below. This mode of compression is adopted in order to obtain high porosity and high permeability as well as low thermal conductivity. The bricks leaving the press are very soft and have to be kept for about six hours in exhaust steam before being dried in the open air. In strength the bricks answer very well in houses of two or three stories, and do not soften under water.

Basic Open-hearth Slags. — At the 1920 meeting of the Iron and Steel Institute (British) JOHN F. WILSON presented some notes derived from his furnace experience on "Slag Conditions in Open-Hearth Basic Steel-Making Practice." Recognizing the fact that when melted, slag constituents are in solid solution with each other, he still was of the opinion that much information could be had from studying the acid: base ratio. Basic slags appear to adjust themselves to the furnace conditions, with the end of maintaining a viscosity not too thick or too thin—something like the consistency of cream. This criterion required somewhat different compositions for different temperatures; if, for instance, the slag is too thin, there must be added to it by the furnaceman sufficient ingredients to rectify the matter, or there will be reduced from the slag such elements as give increased fusibility (Fe, Mn, P), or, thirdly, chemical action will abstract from the tanks or metallic bath such elements as to make the slag less fusible. Correspondingly for slags too stiff.

Starting with that slag which is inert yet contains the highest proportion of acids possible in normal basic furnace work, the author notes that this slag has the desirable or creamy viscosity at the lowest temperature. This is called a "silicate slag." If, after allowing for lime-phosphorus and lime-sulphur compounds, the equivalent FeO + MnO + MgO is more than 0.7 × CaO, the slag will be of the olivine type—purely monosilicates. If less than 0.7 × CaO it is of the mellilite type with perhaps one molecule of bisilicates to two of monosilicate. If excess base is added to olivine slag, that excess quickly combines with acids from the metal to form silicates or phosphates. Excess silica from the metal reduces phosphorus or corrodes the tanks.

High-phosphate slags carry silicates of the olivine type, but are less fusible than silicate slags. Very high-phosphorus slags are of economic importance, but in furnace work tend to carry excess base over the monosilicate requirement. This should be reduced to the minimum so as to keep the working temperature down and the soluble phosphorus up.

Tapping slags are best made up so that the steel is properly purified at a sufficiently high temperature, and by least expenditure of bases. Their constitution is quite complex, and must contain "active" bases in order to purify the metallic bath of S and P. Compounds between bases are probable.

Passing on to the effect of slag upon various furnace reactions, Mr. Wilson says that the principal methods of steel manufacture decrease in some way the depth of slag covering. Thick slag volume retards heat transmission into the metal bath, this requiring high flame temperatures and excessive wear on furnace. It blankets or smothers gas evolution from the steel, thereby slowing down the speed of decarbonization, and the intimate contact between metal and slag during the boil is hindered.

In the discussion, J. H. Whiteley said that one of the unexplained things about basic slags was the method by which iron oxide increased in analysis. It might be given off by the metal, but to only the slightest extent. Metallic globules in the slag might churn to the surface and become oxidized, but ordinarily shot iron in basic slags did not exceed 0.5 per cent, as compared to 5 per cent in the acid slag during the boil, in spite of which percentage iron oxide in the slag is then reduced. The only other possibility was the reaction $Fe_2O_3 + Fe = 3FeO$. While in the acid slag there might be 30 per cent of FeO in the slag as silicate and only 0.2 per cent of Fe_2O_3, in the basic process there might be 8 per cent FeO and 2 per cent Fe_2O_3. Possibly in basic slag the iron oxide was much less closely held in chemical combination and so was relatively free to become oxidized continually by furnace gases.

Silicon in Acid Steel.—A very clear discussion of the reaction occurring when silicon goes up just before tapping an acid heat was presented by B. YANESKE and G. A. WOOD, before the annual meeting of the British Iron and Steel Institute, in their paper entitled "Reduction of Silicon From the Slag in the Acid Open-Hearth Process." It is commonly known that sometimes a heat is tapped which eventually shows much more silicon than counted upon, although carbon and manganese are substantially correct. The authors have been able to study many such heats, following them back and constructing furnace logs, arriving at the conclusion that iron and not carbon is the reducing agent.

Close study shows the following occurrences for high-silicon heats: Silicon will increase continuously in metal if the bath is held quiet under a very siliceous slag; the action is accompanied by a loss in FeO analysis in the slag; yet silicon in the bath will be immediately reduced if either iron ore or lime be added, later to restart the cycle. Meanwhile carbon and manganese are substantially stationary, and may be anything from comparatively high to quite low. Dissolved oxygen in the metal is also very low, because actual losses of C, Mn and Cr during this period of the heat are less than would be expected. Temperature has no preponderating influence on the reduction of silicon and appears to act only indirectly by favoring a more acid slag.

The authors suggest a reaction (necessarily endothermic)

$$SiO_2 + Fe = FeSi + O_2 - ?Cal$$

to explain all these facts, as well as the following: If tests be taken when the silicon first starts to be reduced, they will be pitted on the *under* side (liberation of gas from the slag which surrounds the entire metal in the spoon, but this gas is only imprisoned at the bottom). As the reaction in the furnace becomes stronger, tests are pitted both top and bottom, the holes being connected by badly oxidized channels (passage of oxygenated gas). Tests are pitted in upper surface exclusively, only where there is an excess of oxide in metal, by the reaction

$$FeO + C = Fe + CO$$

Presence of oxide in metal during siliconization is impossible, as explained above, so tests pitted on the upper surface only are not found during the course of this phenomenon.

Campbell* advances the popularly held equation

$$SiO_2 + 2C = Si + 2CO$$

Stoichiometric calculations show that nowhere near enough C is lost from a bath to correspond with its gain in Si. Even if ferrosilicon is melted on the banks, it will largely enter the metal ostensibly by oxidation, through the slag, and reduction, to the metal. Yet silicon can thus be added without lowering carbon an amount demanded by Campbell's equation. It is attractive because silicon is more easily reduced in a high-carbon melt; yet the authors quote figures from low-carbon heats showing siliconization from the slag. A slag over mild steel usually tends to increase in FeO and decrease in SiO_2 near the finish, and more oxygen is liable to enter the melt because of insufficient carbon being present to deoxidize. Siliconization ordinarily cannot be expected from a neutral slag overlying oxidized metal. The authors further state that at furnace temperatures silicon has a greater affinity for carbon than oxygen, so that Campbell's reaction is improbable, basing their argument upon their observations that carbon does not lower in high-silicon metal, until the silicon first is eliminated again, it is commonly known that a newly-sanded hearth produces a quiet boil and requires much more ore to oxidize carbon; in other words, the unusually high silicon then in the metal requires FeO to reduce it first, that done the carbon starts. The apparent inversion of affinities observed when running an acid bessemer very hot is explained thus: high temperatures require highly siliceous slag, which resupply silicon to the metal as fast as it is oxidized. On burning out the carbon to red fumes of iron oxide, the silicon is reduced simply because then enough FeO is produced to lower the acidity of the slag.

McCance† advances the equation

$$SiO_2 + 2Fe = Si + 2FeO - 51\ Cals$$

noting that an increase in temperature would lead to a greater reduction and the formation of more silicon. True, but it would also form more FeO, yet experience shows that the slag actually loses FeO during siliconization, and the action is initiated when FeO in slag is already very low. In fact oreing causes a loss in silicon in the metal. Nor does this reaction explain the holes in test pieces.

*"The Manufacture and Properties of Structural Steel." 1896 Edition. p. 130.

†CHEM. & MET. ENG., vol. 22, No. 14 (April 7, 1920), p. 634.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Synthetic Resins.—Resinous condensation products are obtained by passing a vaporized mixture containing dienes such as isoprene, for example, the mixture of gases and vapors obtained by cracking mineral oil under high pressure, over a heated contact mass (bauxite, fuller's earth, clay, animal or vegetable charcoal, etc.) at a temperature above the melting point of the resin formed, say from 110 to 250 deg. C.; the molten resin is drawn off from the bottom of the contact vessel and solidified. The product is soluble in alcohol or ether, and may be used in the manufacture of varnishes, coating compositions, plastic compositions, insulating materials, etc., and may be vulcanized. (Br. Pat. 138,046—1919. HALL MOTOR FUEL, LTD., London, March 24, 1920.)

Catalysts for Ammonia.—Catalysts for use in the synthesis of ammonia at atmospheric pressure and moderate temperatures and containing as the active constituent a metal which when heated in nitrogen forms a nitride decomposable by hydrogen are prepared by causing an oxide of such metal to react with a reducing metal such as aluminum or magnesium; the reaction mass which constitutes the catalyst contains the catalytic metal in a finely divided state and distributed over the oxide of the reducing metal, and by the use of such a catalyst the synthesis of ammonia is effected at a temperature lower than that necessary with the catalytic metal alone. The following are suitable catalytic metals —lithium, uranium, cerium, lanthanum, thorium, titanium, calcium, barium, strontium, glucinum, zirconium, vanadium and molybdenum; according to an example, finely powdered quicklime is intimately mixed with very finely powdered aluminum or magnesium, and reduction is started by igniting a length of magnesium ribbon introduced into the mixture. To obtain a greater dilution of the active metal in the catalyst, a further quantity of the reducing metal is added, and the reduction process repeated; and to regenerate the catalyst, fresh quantities of catalytic metal oxide and reducing metal are added, and the mixture brought to reaction as before. If the reaction mass is allowed to cool in the air or in pure nitrogen, the catalytic metal is in part converted into nitride, and the resulting catalyst is of increased activity. (Br. Pat. 140,061—1919. L. DUPARC and C. URFER, Geneva, May 12, 1920.)

Vulcanizing India Rubber.—Natural or synthetic rubber is vulcanized by the addition of salts of mono- or di-substituted dithiocarbamic acids and di- or trivalent metals or inorganic radicles, and sulphur, the amount of sulphur being reduced to 2 to 0.2 per cent of the rubber. In an example, a mixing of 100 parts rubber, 0.5 part sulphur, and 1 part pentamethylene dithiocarbonate of zinc, with or without the addition of mineral oxides, reclaimed rubber or substitutes, is vulcanized in the usual manner. (Br. Pat. 140,387—1919. G. BRUNI, Milan. See also 140,388—1919. May 12, 1920.)

Current Events
in the Chemical and Metallurgical Industries

New Jersey Clay Workers Meet at Trenton

The annual summer meeting of the New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society was held at Trenton, N. J., June 25, with morning and afternoon sessions at the Trenton Country Club. This delightful spot proved an ideal location, and brought an inspiring environment to the gathering. About 65 members and guests were present from all parts of the state, as well as from New York and other neighboring sections.

Helping the New Ceramic School

The meeting was called to order shortly after 11 o'clock, opening with an interesting address by Chairman Abel Hansen, head of the Fords Porcelain Works, Perth Amboy, N. J. Mr. Hansen spoke of the new ceramic school at Rutgers' College, New Brunswick, made possible through the securing of an appropriation of $100,000 from the state, during the last session of the legislature, and urged those present to help the movement with suitable donations of burned clay building materials, as well as general ceramic products. In this way, he pointed out, the fund will go even further than anticipated, making the new building a real monument to the State of New Jersey. He also brought out the need for interesting young men in the advantages of the institution, so that a representative class of students would be evidenced at all times. He said that the demand for ceramic engineers was great, and far in excess of the supply.

Sagger Making

The technical session was inaugurated with a valuable paper by Charles F. Gieger of the Carborundum Co., on the subject of "Superior Saggers." This address traced the manufacture of saggers from the mixing of the clay to burning in the kiln, and pointed out some of the errors now prevalent in production, frequently making for saggers good for but one or two heats.

He said that choosing sagger mixtures on the basis of porosity, though a practice of long standing, was not to be recommended, because porosity is not the governing factor; the hot strength of the burned sagger mix and the rate of deterioration in strength on repeated heatings are items that should control the selection of a sagger mix. Most refractory materials, he set forth, have a much lower mechanical strength at temperatures above 1100 deg. C., than when cold, and in most instances, the primary cause is not due to the softening brought about through vitrification; it is simply that the physical properties are not the same at all temperatures.

The speaker explained preferred methods of preparing sagger mixes, covering the dry grinding of several clays together in a dry or wet pan, or in mills, followed by a thorough pugging in a wet pan, with mullers raised slightly. When the mix is thoroughly plastic, the grog is added, and the entire mass fully ground and mixed.

The concluding paper of the morning session was an interesting résumé on the subject of ceramic drying, covering some recent accomplishments in this line, presented by D. H. Applegate, Jr. of Proctor & Schwartz, Inc. The talk was illustrated with a number of lantern slides, showing various mechanical drying installations. Modern developments, it was pointed out, have made possible effective drying of ceramic wares in far less time than ever thought possible, and with a degree of accuracy and uniformity that leaves nothing to be desired.

Studies of Clay in the Raw State

Following a fine luncheon on the veranda of the club house, the afternoon meeting was opened with an illuminating address by A. V. Bleininger of the Bureau of Standards, on the subject of "Studies of Clay in the Raw State." The talk set forth data regarding investigations and experiments now being conducted by the Bureau, and which, it is expected, will terminate in a pronounced value to those in the ceramic industry.

These tests cover such matters as the influence of organic compounds on clay plasticity; the effect of salts in clay as utilized for paper manufacture; the rate of drying with regard to ultimate shrinkage; the introduction of chemicals to bring about desired colors in paper-making clay, and similar topics.

Selection of Refractories

Mr. Bleininger's address was followed by an equally interesting and pertinent talk by R. M. Howe, Refractories Manufacturers' Association, Mellon Institute, on the topic of "The Selection of Refractories." The address was illustrated with a number of charts showing the results of tests conducted at the institute.

Mr. Howe mentioned facts relative to the mining and mixing of raw clay for the manufacture of firebrick and other high grade refractories. He spoke of the influence of grind on the finished article, making a comparison between finely ground and coarser grade materials. He dwelt at some length on the matter of spalling, and tests conducted along such lines, showing the defined relationship between the amount of grog used and the resistance to spalling.

Firing Wares in Tunnel Kilns

The concluding paper of the meeting was one dealing with the subject of tunnel kilns by Conrad Dressler, American Dressler Tunnel Kilns, Inc., New York. The speaker traced the development of the modern tunnel kiln, and explained the degree of efficiency now obtained in burning spark plugs, electrical porcelain specialties and kindred products. Kilns of this character are being operated to cone 18 and 19, and giving highly satisfactory service.

A number of interesting pictures were thrown on the screen, setting forth various tunnel kiln installations in different parts of the country.

Hercules Powder Co. Sued by duPont Co. for Alleged Patent Infringement

A suit which is not only of interest as a legal battle between two great rival manufacturers of explosives and chemicals but also is of vital importance to practically every manufacturer of pyroxylin solutions, lacquers, artificial and split leathers, and celluloid articles, will soon be brought to trial in the federal district court for New Jersey.

The suit, based on alleged infringement of patents, has been instituted against the Hercules Powder Co. by the E. I. duPont de Nemours & Co. The patents upon which the action was brought, it is claimed by the duPont Co., protect the use of a mixture of ethyl acetate and benzol, with or without the addition of ethyl alcohol, as a solvent for nitro-cotton. As pyroxylin solutions, or dopes, used in the manufacture of split and artificial leathers, lacquers, cements, celluloid articles, and hundreds of other commodities, are frequently made by dissolving nitro-cotton in these solvents, and the two companies are among the leading competitors in the business, this suit assumes a high proportion of interest to many concerns throughout the country. Definitely stated, the patents which it is claimed have been infringed upon are numbers 1,118,498; 1,135,026; 1,321,633 and 1,321,634 granted to the duPont Co. as the assignee of Frederick Kniffen and M. V. Hitt. The two Kniffen patents specifically cover a solvent for pyroxylin consisting of ethyl acetate and benzol and the process of forming a body of pyroxylin made by dissolving pyroxylin in a mixture of ethyl acetate and benzol and then causing this mixture to evaporate. The two Hitt patents cover practically the same proposition, one claiming a solvent for pyroxylin and the other the use of this solvent to dissolve pyroxylin and consequently forming a body of it. The solvent covered is a mixture of ethyl acetate and benzol (or some higher member of the benzol series of hydrocarbons such as toluol), and ethyl alcohol, methyl alcohol, or some other volatile saturated aliphatic alcohol whose rate of evaporation is somewhat similar. This solvent is essentially the same as that involved in the Kniffen patent except that part of the etheyl acetate is displaced by alcohol. This is an alleged improvement on the Kniffen solvent.

It is understood that the Hercules Co. will try to show that the solvent, which is alleged to infringe on the duPont patents, was a matter of common knowledge years before the patents were taken out, and that the only reason ethyl acetate was not very generally employed was the availability and cheapness of other chemicals before it became a commercial commodity. With ethyl acetate on an available basis, it was, according to the belief of the Hercules Powder Co., put to an old and well recognized use in the solvent mixture about which the action has been brought.

Canadian Power Co. to Build Hydro-Electric Plant

The Bridge River Power Co., Ltd., of Vancouver, B. C., is to develop hydro-electric power at the Bridge River power site. A total of 400,000 continuous hp. will be available when the site is fully developed and power in blocks of from 5,000 kw. up will be available within two years' time. Power will be sold as low as $16 per hp. year, depending on whether the plant consuming the power is located at the power house or at a distance, also on the power and load factors.

The Gasoline Problem

In connection with the active and widespread efforts to find substitutes for gasoline Dr. Van H. Manning has expressed the opinion that the problem will be solved primarily by obtaining more gasoline from mineral matter. The following summing up of Dr. Manning's views was made in his capacity as Director of the Bureau of Mines, in fact just before he left the Government service to take charge of the research division of the American Petroleum Institute:

The present situation of high gasoline prices and threatened shortage, has been caused by an increase in the uses of gasoline faster than the increase in production and importations of crude petroleum, from which it is derived. It is now found that sufficient gasoline cannot be obtained from the old processes of refining crude oils to meet the present and anticipated needs. Fortunately, however, processes have been developed in recent years for producing synthetic gasoline from the heavier and less volatile portions of the crude oils, from which processes some 15 per cent of the 4,000,000,000 gal. of gasoline produced in 1919 was derived. Synthetic gasoline can also be manufactured from oil shales and gasoline substitutes are being manufactured from byproduct coke ovens, and can be made by low-temperature destructive distillation of coals and lignites.

I am strongly of the opinion that the problem of obtaining greater supplies of gasoline will be solved primarily by obtaining supplies from mineral matter, and that alcohols and other substitutes derived from vegetable matter can be but a minor factor in the situation for an indeterminate period of time.

Increasing the Yield of Present Oil Fields

Obviously, the most satisfactory solution of the problem would be to obtain greater supplies of crude oil, and for this reason our Government should give serious consideration to the encouragement of our nationals in acquiring supplies abroad. This Government should also do its utmost to provide technical and scientific guidance for the industry at home for the obtaining of more supplies of oil from our own fields. It is a fact not commonly known even in the oil industry, that the wells obtain but a small proportion of the oil which exists in the sands and that probably not more than from 10 to 20 per cent is commonly extracted. Oil is found in sands and sandstones in pores which are almost microscopic in size. When the gas which forces this oil out of the pores of the sands is exhausted, the remaining oil is held like water in a sponge and the well ceases to yield oil in commercial quantities although a larger part of the 80 to 90 per cent of the oil remaining can be obtained by the proper methods.

Some exceedingly promising methods have been in use for a number of years, which have proved indisputably that a great deal more oil can be obtained from our oil sands. But there are numerous important problems which will call for the best scientific and technical research for their solution before a full measure of our oil supplies can be obtained. I am strongly of the opinion that one of the first considerations in insuring a future supply of gasoline should be of this 80 to 90 per cent of the oil which is now being left in our fields, and that this Government should properly conduct the necessary technical and scientific investigations and foster the use of improved processes in every way possible.

Another problem which should receive immediate

consideration is the manufacture of synthetic gasoline from heavy oils. At the present time there is only one process which is being largely used—the so-called Burton cracking process held under patent by the Standard Oil Co. of Indiana. This process can use only one quality of oil, which is but a minor proportion of the heavier oils produced in this country. Some 40 to 50 per cent of all petroleum which is now being used in a most inefficient manner for steam raising would be made available for manufacture into synthetic gasoline by the development of a commercially practical process for cracking these heavy oils into synthetic gasoline. The discovery of such a process available to all refiners might readily double the quantity of gasoline obtainable from our present production of crude oil and defer any apprehension of a gasoline shortage for many years to come.

Gasoline From Oil Shales

In recent years, vast quantities of shales have been found in the Rocky Mountain states, in California, Kentucky, and many other states, from which can be obtained from half a barrel to over a barrel of oil per ton of shale. The U. S. Geological Survey estimates that the quantity of oil locked up in the shales of Colorado, Utah and Wyoming, is many times more than will ever be produced from our oil fields. From these shales, gasoline and other petroleum products may be obtained by retorting and refining. This has been a commercial process for over fifty years in Scotland. In fact, petroleum products were obtained in the United States from oil shales before the discovery of oil. Although there is considerable interest and experimentation going on looking to the utilization of these enormous supplies of petroleum products in the West, there are many problems to be solved before oils can be obtained successfully from shales. And to those who are endeavoring to develop this latent resource, there is need for the Government to render every service and encouragement in the way of research and otherwise, in order to hasten the date when oil from shales may be made available.

Substitutes From Byproduct Coke Ovens

A considerable quantity of gasoline substitutes is now being obtained from byproduct coke ovens. It is expected that 95,000,000 gal. of benzol will be produced in 1920, which will be about 2 per cent of the total gasoline supplies for the year. Everything should be done to encourage and foster this industry. Still larger quantities of gasoline substitutes can be made by retorting the coal and lignites which now are being consumed as they come from the mines. If the available oil could be extracted from every ton of coal and lignite before they were consumed, it would add very greatly to the supplies of motor fuels. I wish to point out that the production of benzol from coals is likely to be inseparable from the utilization of alcohols from vegetable matter. It is a fact that the present gasoline-using engine cannot use straight alcohol satisfactorily; also, it is going to be practically necessary that any substitute for gasoline as an engine fuel must be practically interchangeable with gasoline. To accomplish this purpose it is necessary to blend alcohol with gasoline. But alcohol will not blend with gasoline unless there is a considerable quantity of benzol or a similar product in the mixture. Therefore, unless some other solution of this problem is found, it will be necessary to produce large quantities of benzol from coal in order to blend the alcohol with gasoline and make it an interchangeable fuel.

Alcohol From Vegetable Matter

At the present time but a comparatively small amount of alcohol produced from sugar refinery wastes is being placed on the market in competition with gasoline. This is being sold as alcohol, benzol, ether and gasoline blends. However, the quantity of alcohol obtainable from sugar refineries is negligible compared with our gasoline needs.

It is true that there are immense quantities of waste vegetable matter throughout the country, and were it possible to gather the refuse from the farms and from the lumber camps and other places, a tremendous quantity of alcohol could be obtained. But it is unfortunately true that this waste vegetable matter is widely scattered and in few places is it concentrated enough that it seems commercially feasible to make alcohol in competition with gasoline.

From a quantitative standpoint, petroleum, coal, and oil shale are likely to be the cheapest raw material for making gasoline substitutes. It must be borne in mind that the obtaining of gasoline substitutes alone will not solve the problems resulting from the failing petroleum supply. Gasoline is but one of the essential products from petroleum. An automobile, or farm tractor would be even more helpless without the lubricants obtained from petroleum than without the gasoline. There is not a moving part in any piece of machinery in the United States which does not take lubricants which are derived from petroleum.

Suggested Lines of Investigation

It would be a mistaken policy to limit the investigation of gasoline substitutes to vegetable matter. Emphasis should be placed on the investigation of the problems mentioned. Serious consideration should be given to encourage the development of gasoline and gasoline substitutes; (1) by increasing the recovery of oil from our oil fields, (2) by developing processes for making synthetic gasoline out of heavy oils, (3) by encouraging the development of processes for making gasoline and gasoline substitutes out of oil shales, coals, lignites, peats, and (4) by developing processes for making alcohols, ethers, etc., from waste vegetable matter.

Chemistry Co-operating in Plant Protection

Progress was achieved at the Rochester meeting on June 23 when a group of about thirty-five persons met under the auspices of the National Research Council and adopted tentatively articles of association for the proposed "Plant Protection Institute." This is one of the products of the vigorous effort by Dr. H. E. Howe, who is preaching the gospel of co-operative research and industrial development.

This movement includes entomologists, plant pathologists, and the makers of insecticides, fungicides, and the manufacturers of apparatus for the use of these materials. Agencies formally co-operating are the American Society of Economic Entomologists, the American Phytopathological Institute and manufacturers of equipment. It is hoped that standardized labels, standard directions for application of these materials and other similar co-operation can be achieved as well as the much needed research in the chemical and plant industry fields.

Swenson Evaporator Co. Wins Suit

The Swenson Evaporator Co. of Chicago, Ill., a company engaged in the manufacture of evaporators for various industries, sold to the Minneapolis & Ontario Paper Co. for its plant at International Falls, Minnesota, equipment amounting to $170,000 in 1916. This material was delivered to the paper company so that the mill could be put in operation within less than a year.

Early in 1919, the evaporator company filed suit in the United States District Court at Minneapolis for the remaining amount due in accordance with contract, which was long overdue, claiming about $40,000 and interest.

The paper company claimed that this money was not paid as the machinery was not built according to contract and filed a counter-claim for damages to the extent of $700,000, this amount being gradually reduced by rulings of the court to $92,000, as representing the maximum amount that could be due the defendant in case the jury decided they were entitled to any damages at all.

The trial opened on June 7, before Judge Booth of the United States District Court, in St. Paul, and lasted three weeks.

The paper company relied mainly upon the testimony of two former employees of the mill, Norman E. Brokaw and Prof. Adolph F. Myer.

The evaporator company's witnesses included Robert Woodhead, superintendent of the Canada Paper Co., C. F. Beyerl, who had charge of the construction of the mill in question and various employees and officers of the Swenson Evaporator Co.

The testimony proved, according to the verdict reached by the jury, that the troubles of the paper company were due to incompetent management and operation, and not to any faulty design or defects in material furnished. It was shown also that the machinery and plant were never given a fair trial, and that similar machinery made by the same company was giving satisfactory service at other pulp mills when operating on similar materials.

The case was submitted to the jury June 25, 1920, and a verdict for the Swenson Evaporator Co. for $43,862 returned the next morning.

Chemical Merger Expected

Negotiations looking to the merger of several of the large byproduct and chemical companies are said to be progressing satisfactorily. The plan involves the merger of the General Chemical Co., Barrett Co., Semet-Solvay Co. and National Aniline Co. It is possible that an announcement bearing upon the proposed merger may be made before the close of the month. Prices at which the shares of certain of the subsidiary companies will go into the merger have been agreed upon.

It is understood that the aggregate earnings of the companies to be embodied in the merger—Barrett, National Aniline, General Chemical and Semet-Solvay—are now running at rate of $30,000,000 annually of which National Aniline contributes about $12,000,000.

Germany's Potash Industry

It is reported that the net profit of the German potash industry for the year 1919 was 7,661,511 marks, as compared to 2,317,667 marks for 1918.

Personal

COMFORT A. ADAMS, dean of Harvard School of Engineering, has resigned to devote his entire time to the work of the National Research Council, in which he is chairman of the Engineering Division.

Dr. EDWARD BARTOW, of Illinois University, has accepted a position as head of the chemical department for Iowa State University, Iowa City, Iowa.

FRED A. BIGELOW has been elected president of the Carpenter Steel Co., Reading, Pa., succeeding W. B. Kunhardt, who becomes chairman of the board of directors.

W. D. COLLINS has been designated as chief of the Quality-of-Water division of the United States Geological Survey. Mr. Collins formerly was a member of the chemical staff in the Water Resources laboratory of the Survey. For several years, however, he has been serving as a chemist in the Bureau of Chemistry, Department of Agriculture.

C. B. HOCKER, of the engineering department of the Western Electric Co., New York, is making an extended visit to the Chicago plant.

Prof. HECTOR JAMES HUGHES has been made dean of the Harvard University Engineering School, Cambridge, Mass., to succeed Comfort A. Adams, resigned.

Colonel ARTHUR B. LAMB, who is now in charge of the research laboratory of the Nitrate Division, at American University, Washington, D. C., has decided to resume his duties at Harvard University, and will return there in September.

J. B. MCINTOSH, well known among copper and lead men in the West, has resigned as superintendent of construction, Murray Plant, American Smelting and Refining Company, to accept the position of chief mechanical and construction engineer for Compañia de Real del Monte Pachuca, and will leave for Mexico July 15. Mr. McIntosh acted as civil engineer for the Anaconda Copper Mining Company for many years, having a prominent part in the construction of the Washoe Smelter. In 1907 and 1908 he acted as engineer in charge of construction for the Tooele Smelter, built by the same interests, resigning to go to Bisbee, Arizona, where he directed the preliminary work on the Clarkedale Smelter. For the past 8 or 10 years he has been attached to the engineering division of the Utah department, American Smelting and Refining Co. and has executed several notable improvements in their plants during that time.

HARRISON E. PATTEN has resigned from his position as physical chemist in the Bureau of Chemistry, Washington. He left his work there on the first of the present month.

W. N. PRITCHARD, Jr., formerly superintendent of a pulp mill of the Procter & Gamble Co., Augusta, Ga., is now doing research work on dyes for the Calco Chemical Co., Bound Brook, N. J.

GEORGE W. SARGENT has severed his connection with the Crucible Steel Co. of America as vice-president and metallurgist, and is now devoting his attention to the Molybdenum Corp. of America, of which he is president.

EARL STAFFORD has recently become a member of the engineering staff of Arthur D. Little, Inc., chemists and engineers, Cambridge, Mass. Mr. Stafford is a graduate of the Engineering School of Tufts College, 1908, and for the past twelve years has devoted his attention largely to hydroelectric developments with particular reference to ore treating plants, pulp and paper mills and light and power companies.

R. H. TAWNEY, who was a representative of labor on the so-called Sankey Commission investigating the English coal situation, spoke before the Chicago City Club on July 1 on the subject: "The Movement for the Nationalization of Mines in England."

ROBERT V. TOWNSEND, formerly chemist in charge of the chlorinated toluene products, Semet-Solvay Co., Syracuse,

N. Y., has accepted a position with the Victor Talking Machine Co., Camden, N. J., where he will organize and direct its department of chemical research.

Prof. ALFRED H. WHITE, head of the department of chemical engineering, University of Michigan, has sailed for France to be gone about a month in the interest of the Air Nitrates Corporation of New York City.

C. W. WRIGHT, of Rome, Italy, and his brother, C. A. Wright, formerly of the U. S. Bureau of Mines, sailed July 8 for Italy, on the S. S. Canopic. Their address will be 28 Via Parlamento, Rome.

Obituary

L. H. HASKELL, vice-president of the Southern Cotton Oil Co., died at his home in Savannah, Ga., on June 4, 1920.

B. F. MECHLING, director of Mechling Brothers, manufacturers of heavy chemicals, Camden, N. J., died on July 2, at his home in Philadelphia. He had been ill for the past two years but his condition was not serious until recently. In addition to his conection with Mechling Brothers he was president of the Albro-Clem Elevator Co. and the Elevator Safety Appliance Co., both of Philadelphia. Mr. Mechling was 73 years of age and is survived by his widow and three children.

Current Market Reports

The Non-Ferrous Metal Market

New York, July 9, 1920.—The outside market has advanced to 18.50c., as copper stocks dwindle. Spot lead practically does not exist. Zinc stocks, also, are very low.

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots	7.62½@7.87½
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48.50
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	7.75
Zinc, spot, New York	8.00
Zinc, spot, E. St. Louis	7.60

OTHER METALS

Silver (July 8)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	80@85
Iridium	oz.	300
Palladium	oz.	75@80
Mercury	75 lb.	90@92

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	43.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp	14.50@15.00
Copper, heavy and wire	14.25@14.75
Copper, light and bottoms	12.75@13.75
Copper, heavy cut and crucible	15.00@15.50
Brass, heavy	9.00@10.00
Brass, light	7.00@ 7.50
No. 1 clean brass turnings	9.00@ 9.50
No. 1 comp. turnings	12.50@13.00
Lead, tea	4.50@ 5.00
Lead, heavy	6.50@ 7.00
Zinc, scrap	4.50@ 5.00

The Iron and Steel Market

Pittsburgh, July 9, 1920.

In the iron and steel industry production has increased and shipments have decreased, "Order No. 7" of the Interstate Commerce Commission being blamed for the latter and receiving no commendation for the former. It operates to decrease the supplies of open top cars for loading Connellsville coke and for shipping pig iron and steel products, while the increased supplies of cars to coal mines have brought about a better distribution of coal, the byproduct coke ovens and steel mills being beneficiaries among others. What the iron and steel industry wants is to ship its accumulation of product, not means to produce still more and pile at a still greater rate.

JUNE PRODUCTION OF PIG IRON

Production of pig iron in June was at the rate of about 37,400,000 gross tons per annum. On the basis of estimating capacity under ordinarily favorable working conditions at 45,000,000 tons, rates of production have been approximately 90 per cent in March, 75 per cent in April, 79 per cent in May and 83 per cent in June. At the recent rate of increase October would see 100 per cent production. The March rate was the highest since October, 1918, the rail strikes coming in April, with a gradual recovery thereafter.

The report on steel ingot production in June is not yet available, but it seems fair to assume that ingot production has continued in relation to pig iron production, in which case the June rate of ingot production was about 43,200,000 gross tons per annum, capacity being somewhere between 50,000,000 and 55,000,000 tons, and probably nearer the higher figure. Normally the production of finished rolled steel is about 76 per cent of the ingot production, but at the present time the proportion is much less, as many mills are accumulating semi-finished steel, partly by reason of greater convenience in piling and partly because of uncertainty whether customers will want all steel that would now be rolled according to their specifications, at the late date at which some of the steel would be shipped, for even the point of shipping current production has not been reached, reduction of the accumulation being still farther in the future.

QUIET MARKETS

There is very little interest in the pig iron and steel markets, which are all very quiet, except for business between the Steel Corporation subsidiaries and their regular customers, which business has become of practically routine character, the customers having confidence in the Steel Corporation prices on account of their being lower than the prices named by any of the independents. Contracts and orders are placed even though the time of delivery is altogether uncertain. The matter of delivery is really a detail as the corporation is selling to customers who are now receiving steel, as far as shipping conditions permit, and it is merely a matter of extending the service, as time passes, for additional periods.

Little attempt is being made to prognosticate the future of the iron and steel markets, as everything is seen to hinge on transportation conditions, and the outlook in that respect is of course cloudy. Few observers doubt that transportation conditions really will improve very materially and long before winter, when indeed a fresh batch of troubles is likely to come. Three dates are to be mentioned as promising, directly or indirectly, some help in transportation by producing greater incentive to utilize to the best advantage the existing physical facilities: July 20, when the Railroad Labor Board is expected to make its awards; August 1, when the decision in the freight rate cases is expected; September 1, when the Government guarantee of railroad earnings expires and the railroads will have to earn whatever money they get.

LABOR OUTLOOK CLEAR

The Columbus convention reached an agreement in the matter of wage rates in sheet and tin mills hitherto controlled by the Amalgamated Association. The men receded

from their various strong demands, and some entirely minor concessions were made them. Several manufacturers who have hitherto been content to sign the Amalgamated Association scales year by year after the usual negotiations are now strongly disposed to discontinue this practice when a scale year terminates under conditions auspicious for such an undertaking. The workers' organization has controlled less than 40 per cent of the sheet and tin mills of the country, all the Steel Corporation mills, for instance, being open shop, and the organization has been largely in the nature of an employment agency, affording facilities for the manning of mills and their operation by dealing with a mill committee in the matter of petty grievances rather than with individuals. At some of the mills built in the past few years the scale has been signed from choice, on the belief that the plants could thus be gotten into operation more quickly. With the open shop such an important issue with the industry in general, such a disposition has disappeared.

Now that the American Federation of Labor has conceded to the Amalgamated Association jurisdiction in case of an effort to unionize the iron and steel industry as a whole, by promising the Amalgamated Association a 51 per cent vote on any organizing committee the federation may set up pursuant to the resolution at the recent Montreal convention, the common opinion in the iron and steel industry is that no general organizing effort will be made. In the circumstances there is not much incentive for the American Federation of Labor to undertake such an operation, while there is nothing in the recent history of the Amalgamated Association, in its narrow sphere, to attempt so large a proposition. The Amalgamated Association would not think of conducting such an organizing campaign as that of last year, with its very radical atmosphere, as the association is distinctly conservative, and yet as to producing results by way of a strike the methods pursued last year were easily the most likely to succeed, even if a strike based on agitation of such a character could not be expected to succeed.

The definite reason why the iron and steel industry has remained so readily on the open shop principle is that it has payment by results as to practically all its skilled labor, the remedy for labor unrest urged as the most effective in all recent councils on this subject, and the principle of payment by results is likely to be extended from time to time in the industry to reach men farther down than those now paid definitely on a tonnage basis.

The Chemical and Allied Industrial Markets

New York, July 9, 1920.

The chemical market is in the same erratic buying position that it has occupied recently. Offerings are few enough, at what buyers consider a fair price, and consequently there is little activity displayed. The transportation situation seems to be relieved somewhat and deliveries on contracts are being made more rapidly than they have for some time. The *potassium salts* have held firm throughout the period with some offerings of *caustic* being made at 30c. while other interests are holding out for 38@40c. per lb., but even at these figures there is very little material visible. *Bichromate of potash* is steady at 44c. on spot, with possible shading of few cents for future contract as producers are unable to take care of anything but contract business. Manufacturers have advanced the price of *potassium chlorate* to 16@17c. per lb., which represents a rise of 1c. per lb., caused by recent heavy demand. Current prices of *potassium bromide* are holding firm and 90c. is the average price with some interests going as high as 95c. per lb. *Copperas* has fallen off slightly to $2.75@$3 per cwt. against $2.90@$3 of the previous report caused by drop in the volume of business. It is impossible to locate *salt cake* for less than $40 and as high as $50 per ton is being quoted on material that has changed hands several times. A year ago $8-$10 per ton was a reasonable price. Offerings of *barium chloride* are being made at $158@$165 per ton and there is promise of the domestic market returning to normal in the face of importing competition. There has been little or no activity among the *acids* and previous quotations prevail.

Despite the predictions made earlier in the year that there would be a sharp decline about July 1, the coal-tar products market maintains that inactive appearance that is becoming habitual, and from indications will continue to do so. It is thought by many that, if for no other reason than the Japanese money situation, this drop is bound to occur and has been merely deferred until the late fall. On the other hand, the more optimistic members believe that Japan is safely over the crisis and will be back in the market soon, which will have the effect of not only keeping prices firm but will also strengthen them. *Phenol* remains in good supply and Government resale material can be obtained at 12c. per lb. It was estimated that the 27,000,000 lb. placed on the open market, with conditional clauses against exportations and selling to jobbers, would last four years, based on the approximate consumption of 6,000,000 lb. per year, but there is some speculation rife as to whether this supply will hold out. However, the firm that is handling this material is certain that it will be available for at least a year or year and a half. There is no *naphthalene* being offered except in small lots and 19@21c. per lb. is being demanded. *Metaphenylenediamine* came up during the week and is quoted at $1.23@$1.30 per lb. against a low price of $1.15 of the previous week. The supply of *aniline oil* and *salts* seems to be better and prices on these two items are easier at 32@38c. for the former and 40@45c. per lb. for the latter. *Beta-naphthol*, tech., is quoted at 88c. per lb. for spot material and 80@82c. on contract; the *sublimed* grade is nominally quoted at the same figures, but there is no material available. Producers of pure *benzol* have made an advance to 35@40½c. per gal., f.o.b. works, drums extra and returnable. *Toluol* and *solvent naphtha* were also advanced, the new quotations being 35@40c. per gal. for the former, and 30½@35½c. per gal. for the latter. These items forming the basis for most of the coal-tar products, there seems to be no indication of a weak and falling market.

Waxes

Paraffines hold the center of interest in this market. Scarcity combined with heavy demand is tending to hold prices at the present high levels. The different grades of this wax had range between 7@12½c. per lb., a year ago, against current range of 9@18½c., and it is thought that still higher levels will be reached. The flooding of the market with 2,000 tons of *carnauba*, No. 3, North country, has caused a drop in this item, which is now listed at 36@37c. per lb. against 43@44c. until the current quotation. *Japan* wax has been affected by the money conditions in the East and is considerably weaker at 19@19½c. per lb.

Naval Stores

This market is fast approaching last year's figures. In the case of the rosins it is already below that market which was quoted at $15@$16.95 for B-D grade, against $12@$15.95 current quotations. *Turpentine* a year ago was selling at $1.10, and if present conditions prevail it will not be long before this limit is reached. Buyers are very few even at the present $1.49 level, which is almost $1 below the price asked three months ago.

Miscellaneous

Molybdenum ore shows a marked increase in activity after a long interval of dullness. While the ore is now quoted at $1 per lb. of MoS_2, an advance from 85c. business has been transacted at considerably below the dollar mark. The ore in most of these instances, however, represents odd lots and war-time stock purchased from munition works. The greater use of molybdenum for the making of parts in the automobile industry has done much to open up business.

In the *feldspar* market there has been an upward movement, with orders at least three months in advance of available stock. Little has been done toward working the Connecticut resources for the last six months and the Canadian mines show a similar inactivity. The ground product, f.o.b. New York State and North Carolina, is quoted at $17 per net ton, a rise of $1 within the week.

Connellsville coke is nominal at $18@$19, foundry, and $17.50@$18.50 furnace, with very little obtainable.

The Chicago Market

Chicago, Ill., July 8, 1920.

Quiet is the ruling spirit in local markets. On many items the difference between spot and future quotations is as high as 50 per cent, indicating that lower spot prices will arrive some time. This tends to discourage spot buying beyond certain and definite needs. A great portion of the capacity of producers is tied up under contract, which fact has driven the immediate and early delivery business into the hands of brokers and speculators. These interests, being affected by the general financial tightness, seem unable to hold prices in the face of weak demand and the general trend of the market is therefore downward.

Transportation conditions are improving. Last week an embargo was placed on intercity shipments in the Chicago District, embracing Hammond, Gary and similar nearby points. This was with a view to permitting the carriers to clear out the accumulation of through shipments, some of which have been stalled for weeks. Consumers depending for supplies on consignments from far-away points are being benefited thereby. Considerable worry as to the coal situation has been expressed, fears of a shortage during the coming winter being prevalent. A careful survey of the situation, however, indicates that there is no cause for alarm and production is keeping pace with demand, which is all that is ever expected this time of year.

Heavy Chemicals

In general, spot market is weak, even in the face of very low supply and, as producers are well sold up for some time to come, but few transactions are recorded for future delivery. Shortage in *alkalis* is most pronounced, with prices changed but fractionally since last reported. ***Caustic soda*** has been all but unobtainable, the prices mentioned being 6½c. per pound on the solid and 6c. on the granulated. These quotations should be considered as nominal. *Sal soda* shows increasing strength with contract business going at $1.70@$1.75 per cwt., spots running up to $1.90, and goods hard to locate at any figure. *Bleach* and *soda ash* show no change.

Producers of *alcohol* remain wholly unable to keep up with demand, the scarcity of the *methyl* grade being most pronounced. Not only are manufacturers having difficulty in securing molasses but the supply they do get is weaker in sugar content than that formerly obtained, owing to a greater effort by the sugar refiner to extract all the sugar possible. This is caused by the present abnormal price on sugar, and the apparent impending break in this commodity may relieve the condition. Meanwhile, the conversion of molasses plants to corn continues. *Denatured* alcohol, normally around 50c. at this time of the year, is firm at $1.09 per gal., owing to its wide consumption by industries ordinarily using *methyl*. *Methyl*, when found, is going at $3.65 per gal. for 95 per cent and considerable contract business is being closed both at that figure and on an open price basis. Market on *ethyl* grade is unchanged. *Formaldehyde*, still hampered by alcohol shortage, remains scarce with price firm at 55c.

Mercury remains firm at a price of $90 per flask, which is notable in view of the fact that various mercurial products which are factors in the drug trade were reduced by the manufacturers. *Aqua ammonia*, on contracts, remains unchanged, but practically all spots are second hand, on which definite quotations are unavailable. Transactions in carboys ranged up as high as 15c. per pound for 26 deg. Demand for *sal ammoniac* is off and price has dropped on the lump variety to 23@24c. per lb. and on the refined gray to 16c. Domestic *barium chloride* is hard to get. The imported is quoted at $175 a ton, nominally, as local supply is about exhausted. *Carbon tetrachloride* is weak on spots, 11c. being the high figure on recent transactions. Contracts cannot be negotiated at much below 13c.

Nothing of interest has occurred in the acid trade in the past fortnight other than a reduction in producers' quotation on *pyrogallic*. Makers now offer the re-sublimed at $2.35@$2.40 per lb. and the crystals at 40c. less.

Coal-Tar Products

The great shortage in all classes of coal-tar products still maintains although reduced activities in the textile industry should cause a lessened call for colors. Inquiry remains light, in the face of which advances were registered July 1 on *naphtha*, *benzol* and *toluol*. Pure *benzol* is now quoted at 35c. per gal., *naphtha* at 30c. and *toluol* at 35c. As producers are far behind on contracts and but few transactions are recorded in spots, these prices are almost nominal. Ordinary routine transactions in the acids have left prices unchanged.

Formerly noted uncertainty in price on *aniline salt* has ended with the price firm at 38c. per lb. The same is true of *aniline oil*, 33½c. being current. The advance in *benzol* indicates no further depression on these items. Spot stocks of *naphthalene* are practically exhausted and quotations depend on the buyers' need for supplies. Fluctuation is so great as to render a report useless.

Vegetable Oils

Buyers' apathy continues. Favorable growing weather for cotton coupled with an optimistic government crop report served to discourage *cottonseed oil* buying and nothing has occurred to stimulate the demand on any other item in the line. *Linseed oil*, suffering from the public's refusal to buy on a declining market, is moving slowly, but the price is firm at from $1.54 per gal. in tank cars to $1.64 in barrels f.o.b. warehouse. All other oils in this market show but fractional changes.

Naval Stores

Turpentine on local sales has declined abruptly from a figure of $2.20 a gal. two weeks ago; it is now down to $1.75 to $1.85, with buyers showing no eagerness to load up. No great business is to be anticipated until prices demonstrate stability. Transportation conditions are considerably improved so that immediate requirements are being filled with little trouble.

Pine oil, both pure and destructively distilled, remains very hard to get, and is unchanged in price.

The St. Louis Market

St. Louis, Mo., July 6, 1920.

There has been little change in the chemical market during the past two weeks and prices for the most part have remained stationary. Local stocks are low, especially of chemicals which are not produced locally. The railroad situation has not improved materially and carload shipments are slow and deliveries erratic.

Heavy Chemicals

Local producers report little spot buying but many inquiries by contract buyers. The market for *sulphuric acid* is quiet and prices unchanged. The 60 deg. grade is quoted in carload lots at $15 to $16 per ton and 66 deg. grade at $22 per ton. The demand for *oleum* continues light and price is unchanged at $27.50 per ton. There has been little change in the demand for *muriatic acid* and the price remains at $25 per ton in carload lots and 2@2¼c. per pound in carboys for the 18 degree grade. The supply of *sodium bisulphate* is very short and the demand good. Quotation remains unchanged at $6 per ton in carload lots.

The market for *nitric acid* is quiet and prices unchanged. The 36 deg. grade is quoted at $7 per cwt., 38 deg. grade at $8, 40 deg. grade at $9 and the 42 deg. grade at $10, in carload lots. The recent action of the Chilean association of producers in advancing the prices of *nitrate of soda* will undoubtedly cause an increase of price of *nitric acid*, as soon as the new supplies reach the market.

Quotations on *phenol* are unchanged at 12c. per lb. in quantities 15 tons and over. The supply is plentiful, due to a local firm disposing of surplus Government stock. The supply of *zinc oxide* is very limited and manufacturers are quoting on third quarter delivery. Prices are firm at 9@10½c. per lb., depending on the grade.

There is a fair demand for *caustic soda* and supplies are more plentiful. Prices are unchanged at $6.25 per lb. in carload lots. *Soda ash* is unchanged at $3.75 per lb.

The supplies of all grades of *alcohol* are very limited and the demand light. Denatured *alcohol* in Nos. 4 and 5 grades is quoted at $1.06 per gal.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....	$0.65 – $0.75
Acetone	lb.	$0.15 –$0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.50
Acetic, 56 per cent	cwt.	6.00 – 7.50	8.00 – 9.00
Acetic, glacial, 99½ per cent, carboys	cwt.	15.50 –16.00	16.50 – 17.50
Boric, crystals	lb.	.15 – .15½	.15½– .16½
Boric, powder	lb.	.15 – .15½	.15 – .16
Citric	lb.	1.05 – 1.12	1.17 – 1.18
Hydrochloric (nominal)	cwt.	2.00 – 3.00	3.10 – 3.25
Hydrofluoric, 52 per cent	lb.	.13½– .14	.14½– .15½
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½– .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06 – .07	.07½– .08½
Nitric, 42 deg	lb.	.07½– .08	.08½– .09½
Oxalic, crystals	lb.	.55 – .57	.60 – .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.25 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 –19.00	..... – .....
Sulphuric, 60 deg., drums	ton	..... –	..... – .....
Sulphuric, 66 deg., tank cars	ton	23.00 –24.00	25.00 – 26.00
Sulphuric, 66 deg., drums	ton	35.00 –40.00	45.00 – 50.00
Sulphuric, 66 deg., carboys	ton	36.00 –40.00	50.00 – 55.00
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 –30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 –30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 –35.00	40.00 – .....
Tannic, U. S. P	lb.	1.45 – 1.50	1.55 – 1.60
Tannic (tech.)	lb.	..... –	.60 – .90
Tartaric, crystals	lb.	..... –	.80 – .85
Tungstic, per lb. of WO	lb.	..... –	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl, 95%	gal.	..... –	3.25 – 3.30
Alcohol, Methyl, pure	gal.	..... –	3.50 – 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	..... –	1.10 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	..... –	1.05 – 1.10
Alum, ammonia lump	lb.	.04½– .05	.05½– .06
Alum, potash lump	lb.	.07½– .08½	.09 – .09½
Alum, chrome lump	lb.	.15½– .18	.19 – .20
Aluminum sulphate, commercial (nominal)	lb.	.02 – .03	.03½– .04½
Aluminum sulphate, iron free	lb.	.03½– .04	.04½– .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½– .10½	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½– .13½	.13½– .14½
Ammonium nitrate	lb.	.08½– .09½	.10 – .11
Ammonium sulphate	lb.	.07 – .07¼	.08½– .....
Amylacetate	gal.	..... –	5.00 – .....
Amylacetate tech	gal.	..... –	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½– .16	.16½– .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 – .21	.22 – .23
Barium chloride	ton	150.00–160.00	..... – .....
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.09½– .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½– .05	.05½– .06
Bleaching powder (see calcium hypochlorite)		..... –	..... – .....
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax (see sodium borate)		..... –	..... – .....
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	..... – .....
Calcium carbide	lb.	.04½– .04½	.04½– .05½
Calcium chloride, fused, lump	ton	23.00 –25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½– .01½	.02 – .02½
Calcium hypochlorite(bleaching powder)	cwt.	4.00 – 4.25	4.50 – 6.50
Calcium peroxide	lb.	..... –	1.50 – 1.70
Calcium phosphate, monobasic	lb.	..... –	.75 – .80
Calcium sulphate, pure	lb.	..... –	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.12 – .13	.13½– .15
Carbonyl chloride (phosgene)	lb.	..... –	.80 – 1.05
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.30 – .35	.36 – .38
Cobalt oxide	lb.	..... –	2.00 – 2.05
Copperas (see iron sulphate)		..... –	..... – .....
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	..... –	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		..... –	..... – .....
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl Acetate Com. 85%	gal.	1.35 –	1.40 – .....
Ethy Acetate pure (acetic ether 98% to 100%)		..... –	1.75 – .....
Formaldehyde, 40 per cent (nominal)	lb	.36 – 40	57 – .65
Fusel oil, ref	gal.	..... –	5.25 – 6.00
Fusel oil, crude (nominal)	gal	..... –	..... – .....
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine	lb.	..... –	26½– 28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	..... –	.03 – .20
Iron sulphate (copperas)	cwt.	..... –	2.75 – 3.00
Lead acetate, normal	lb.	..... –	13½– 16
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	..... –	.90 – 1.00
Litharge	lb.	.14 – .15	.15½– .16
Lithium carbonate	lb.	..... –	1.50 – .....
Magnesium carbonate, technical	lb.	.12 – .14	.15 – .16
Magnesium sulphate, U. S. P	100 lb.	3.00 – 3.55	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	..... –	3.25 – 3.60
Nickel salt, double	lb.	..... –	.14 – .16
Nickel salt, single	lb.	..... –	.16 – .18
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	..... –	.35 – .37
Potassium bichromate	lb.	.44 – .45	.46 – .47
Potassium bitartrate (cream of Tartar)	lb.	.52 – .56	.57 – .58
Potassium bromide, granular	lb.	.80 – .85	.90 – .95
Potassium carbonate, U. S. P	lb.	..... –	.85 – .88
Potassium carbonate, crude	lb.	.21 – .25	.26 – .28
Potassium chlorate, crystals	lb.	$0.16 –$0.17	$0.18 – $0.20
Potassium hydroxide (caustic potash)	lb.	.30 – .33	.35 – .38
Potassium iodide	lb.	..... –	3.35 – 3.60
Potassium nitrate	lb.	.15 – .17	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 – .....
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .36
Potassium sulphate (powdered)	ton	$225.00 –240.00	..... – .....
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	40.00 – 50.00
Silver cyanide (nominal)	oz.	..... –	1.25 – .....
Silver nitrate (nominal)	oz.	..... –	.74 – .76
Soda ash, light	100 lb.	..... –	3.50 – 3.60
Soda ash, dense	100 lb.	..... –	3.55 – 3.65
Sodium acetate	lb.	.08½– .09	.09½– .12
Sodium bicarbonate	100 lb.	2.45 – 2.60	2.75 – 3.50
Sodium bichromate	lb.	.26½– .27½	.28 – .29
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.06 – .06½	.07 – .10½
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.10 – .10½	.10½– .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	4.25 – 6.00	6.25 – 6.50
Sodium hyposulphite	lb.	..... –	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25½– .....
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.16 – .18	.19 – .20
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½– .04½	.04½– .05
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½– .01½	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½– .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.50
Sodiumsulphide, crystal, 60–62per cent(conc)	lb.	.09½– .10	.10½– .11
Sodium sulphite, crystals	lb.	.03½–	.04 – .06
Strontium nitrate, powdered	lb.	.17½– .18½	.19 – .20
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	25.00 –30.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	..... –	3.80 – 4.35
Sulphur, roll (brimstone)	100 lb.	..... –	3.40 – 3.90
Tin bichloride (stannous)	lb.	.42½–	.46 – .50
Tin oxide	lb.	..... –	..... – .....
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran	lb.	.13 – .13½	.13½– .17
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.11 – .12	.13 – .15
Zinc oxide, U. S. P	lb.	.10½– .13½	..... – .....
Zinc sulphate	lb.	.03½– .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40	$1.50
Alpha naphthol, refined	lb.	1.60	1.70
Alpha naphthylamine	lb.	.53	.55
Aniline oil, drums extra	lb.	.34½	.36
Aniline salts	lb.	.41	.45
Anthracine, 80% in drums (100 lb.)	lb.	.90	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	2.10
Benzidine, base	lb.	1.35	1.40
Benzidine, sulphate	lb.	1.15	1.25
Benzoic acid, U.S.P	lb.	.90	1.00
Benzoate of soda, U.S.P	lb.	.80	.90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.35	.40½
Benzol, 90%, in drums (100 lb.)	gal.	.33	.38½
Benzyl chloride, 95-97%, refined	lb.	.35	.40
Benzyl chloride, tech	lb.	.25	.35
Beta naphthol benzoate (nominal)	lb.	3.50	4.00
Beta naphthol, sublimed (nominal)	lb.	.....	.....
Beta naphthol, tech (nominal)	lb.	.80	.88
Beta naphthylamine, sublimed	lb.	2.25	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.05	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.00	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65	.75
Dichlorbenzol	lb.	.08	.10
Diethylaniline	lb.	1.50	1.60
Dimethylaniline	lb.	1.35	1.45
Dinitrobenzol	lb.	.30	.37
Dinitroclorbenzol	lb.	.32	.35
Dinitronaphthaline	lb.	.45	.55
Dinitrophenol	lb.	.40	.45
Dinitrotoluol	lb.	.40	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	.40
Diphenylamine (nominal)	lb.	.80	.85
H-acid (nominal)	lb.	2.25	2.50
Metaphenylenediamine	lb.	1.23	1.30
Monochlorbenzol	lb.	.18	.20
Monoethylaniline	lb.	2.00	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	....	....
Naphthaline, flake	lb.	....	.19
Naphthaline, balls	lb.	....	.19
Naphthionic acid, crude	lb.	.75	.85
Nitrobenzol	lb.	.14	.19
Nitro-naphthaline	lb.	.40	.50
Nitro-toluol	lb.	.18	.25
Ortho-amidophenol	lb.	3.25	4.25
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-nitro-phenol	lb.	.80	1.25
Ortho-nitro-toluol	lb.	.25	.40
Ortho-toluidine	lb.	.35	.45
Para-amidophenol, base	lb.	2.50	3.00
Para-amidophenol, HCl	lb.	2.50	3.00
Para-dichlor-benzol	lb.	.08	.12
Paranitraniline	lb.	1.40	1.50
Para-nitro-toluol	lb.	1.35	1.50
Paraphenylenediamine	lb.	2.50	2.75
Paratoluidine	lb.	2.00	2.50
Phthalic anhydride	lb.	.65	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	.20
Pyridin	gal.	2.00	3.50
Resorcin, technical	lb.	4.25	4.50
Resorcin, pure	lb.	6.25	6.75

Salicylic acid, tech., in bbls. (110 lb.)	lb.	$0.50 —	$0.52
Salicylic acid, U. S. P.	lb.	.50 —	.60
Salol	lb.	.90 —	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½ —	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.25 —	.26
Sulphanilic acid, crude	lb.	.32 —	.35
Toluidine	lb.	1.70 —	2.50
Toluidine, mixed	lb.	.45 —	.55
Toluol, in tank cars	gal.	.35 —	.....
Toluol, in drums	gal.	.38½ —	.40½
Xylidine, drums, 100 gal.	lb.	.50 —	.65
Xylol, pure, in drums	gal.	.37 —	.45
Xylol, pure, in tank cars	gal.	.35 —	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37 —	.45
Xylol, commercial, in tank cars	gal.	.23 —	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36 —	$0.39
Beeswax, refined, light	lb.	.39 —	.40
Beeswax, white pure	lb.	.63 —	.68
Carnauba, No. 1. (nominal)	lb.	1.00 —	1.05
Carnauba, No. 2, regular (nominal)	lb.	.85 —	.88
Carnauba, No. 3, North Country	lb.	.36 —	.37
Japan	lb.	.19 —	.19½
Montan, crude	lb.	.23 —	.25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09 —	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09¼ —	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½ —	.12¼
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½ —	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½ —	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½ —	.18½
Stearic acid, single pressed	lb.	.25 —	.26
Stearic acid, double pressed	lb.	.26 —	.27
Stearic acid, triple pressed	lb.	.27 —	.28

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.80
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$12.00 —	$15.05
Rosin E-I	280 lb.	15.95 —	16.10
Rosin K-N	280 lb.	16.10 —	16.20
Rosin W. G.-W. W.	280 lb.	16.25 —	16.50
Wood rosin, bbl.	280 lb.	17.00 —	17.00
Spirits of turpentine	gal.	1.49 —	.....
Wood turpentine, steam dist.	gal.	..... —	.....
Wood turpentine, dest. dist.	gal.	..... —	.....
Pine tar pitch, bbl.	200 lb.	..... —	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50 —	15.00
Retort tar, bbl.	500 lb.	15.00 —	15.50
Rosin oil, first run	gal.	.70 —	.....
Rosin oil, second run	gal.	.73 —	.....
Rosin oil, third run	gal.	.90 —	.....
Rosin oil, fourth run	gal.	.95 —	1.00

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.36½ —	$0.37½
Upriver coarse	lb.	.26½ —	.27½
Upriver caucho ball	lb.	.27½ —	.28½
Plantation—First latex crepe	lb.	.36 —	.37
Ribbed smoked sheets	lb.	.35 —	.36
Brown crepe, thin, clean	lb.	.36 —	.37
Amber crepe No. 1	lb.	..... —	.40

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½ —	$0.20
Castor oil, AA, in bbls.	lb.	.20 —	.22
China wood oil, in bbls.	lb.	.18½ —	.19½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½ —	.18½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.18½ —	.19½
Corn oil, crude, in bbls.	lb.	.17½ —	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15½ —	.16
Cottonseed oil, summer yellow	lb.	.18½ —	.19
Cotonseed oil, winter yellow	lb.	.21 —	.22
Linsed oil, raw, car lots (domestic)	gal.	1.57 —	1.67
Linseed oil, raw, tank cars (domestic)	gal.	1.52 —	1.62
Linseed oil, boiled, car lots (domestic)	gal.	1.60 —	1.70
Olive oil, commercial	gal.	3.10 —	3.25
Palm, Lagos	lb.	.12½ —	.13½
Palm, bright red	lb.	.13 —	.13½
Palm, Nizer	lb.	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.13 —	.15
Peanut oil, refined, in bbls.	lb.	.22 —	.24
Rapeseed oil, refined in bbls.	gal.	1.70 —	1.72
Rapeseed oil, blown, in bbls.	gal.	1.80 —	1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17 —	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.12½ —	.13½

FISH

Winter pressed Menhaden	gal.	$1.17 —	$1.18
Yellow bleached Menhaden	gal.	1.20 —	1.22
White bleached Menhaden	gal.	1.23 —	1.24
Blown Menhaden	gal.	1.30 —	1.32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00 —	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00 —	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00 —	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00 —	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 —	19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00 —	.....
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00 —	11.25
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60.00 —	80.00½
Casein	lb.	.15 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00 —	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50 —	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	20.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	20.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	.....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00 —	.....
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	..... —	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	..... —	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	..... —	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	..... —	.10
Graphite, crucible, 85% carbon	lb.	..... —	.08
Graphite, crucible, 88% carbon	lb.	..... —	.09½
Graphite, crucible, 90% carbon	lb.	..... —	.10½
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic, lump	lb.	.06 —	.....
Pumice stone, ground	lb.	.04 —	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Soapstone	ton	15.00 —	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9.50 —	14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.00 —	9.00
Talc, rubber grades, f.o.b. Vermont	ton	9.00 —	15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	60.00 —	70.00
Talc, California Talcum Powder grade	ton	20.00 —	35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90- 100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	80- 90
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45- 53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45- ...
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75- ...
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40- ...
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	90
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras
Magnesite brick, f.o.b. Chester	net ton	90- 100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55- ...
Silica brick, f.o.b. Birmingham	1,000	51- 55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50- 55

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.19 —	.20
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20 —	.21
Ferro-manganese, 76-80% Mn.	gross ton	200.00 —	250.00
Spiegeleisen, 18-22% Mn.	gross ton	75.00 —	.....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.50 —	3.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90 —	1.10
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3, f.o.b. Atlantic Seaboard	unit	.70 —	.85
*Coke, foundry, f.o.b. ovens	net ton	18.00 —	19.00
*Coke, furnace, f.o.b. ovens	net ton	17.50 —	18.50
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	.....
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	.....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	..... —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02 —	.....
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.85 —	.90
Manganese ore, chemical (MnO_2)	gross ton	75.00 —	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	1.00 —	.....
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½ —	.....
Pyrites, Spanish, run of mines, ci.f., Atlantic seaport	unit	.12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.20 —	.25
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	.....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50 —	7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V contained	lb.	1.00 —	2.50
Zircon, washed, iron free	lb.	.10 —	.....

*Nominal

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

DUNCAN—Joseph Hardy plans to build a 100-ton cyanide mill at its gold mine here.

District of Columbia

WASHINGTON—The Bureau of Yards & Docks, Navy Dept., has awarded the contract for the construction of certain alterations and additions to the Aeronautical Engine Testing Laboratory Building at the Navy Yard here, to Hyde & Baxter, 711 13th St., N. W., at $14,990. Noted July 6.

Illinois

NEWTON—The city plans to extend the present waterworks system, including a filter plant. Estimated cost, $25,000. Fuller & Beard, Chemical Bldg., St. Louis, Mo., engrs.

Kansas

GREAT BEND—The Sisters of St. Dominic have awarded the general contract for the construction of a 3-story, 50x150-ft. hospital, to T. C. Cork. A chemical laboratory will be installed in same. Estimated cost, $150,000.

Kentucky

HENDERSON—The Lucking Distributing Co., Cincinnati, O., has purchased the plant of the Peerless Distilling Co., here, and plans to make improvements and install machinery in same, for the manufacture of grain alcohol. Estimated cost, $30,000.

LOUISVILLE—The Dixie Belle Refining Co., 701 Inter-Saw Bldg., plans to build a refinery on Western Parkway.

LOUISVILLE—The Stall Oil Refining Co., 733 River Rd., is in the market for lubricating machinery.

Maryland

ST. HELENA—The Glidden Co., Madison Ave., N. W., Cleveland, O., has purchased the lithopone plant of the Chemical Pigments Corp., here, and plans to increase the capacity of same.

Massachusetts

CAMBRIDGE—The Presto-Lite Co., Inc., 30 East 42nd St., New York City, will receive bids until August 5 for the construction of a 1-story, 25x100-ft., acetylene plant, here. Estimated cost, $80,000. Noted April 14.

SPRINGFIELD — The Westinghouse Electric & Mfg. Co., Page Blvd., has awarded the contract for the construction of a 1-story, 125x160-ft. foundry, to Bernard H. Prack, Keystone Bldg., Pittsburgh, Pa. Estimated cost, $35,000.

Michigan

DETROIT—The Michigan Grey Iron Castings Co., Harbaugle Ave. and Wabash Ry., is in the market for miscellaneous foundry equipment for plant addition.

GRAND RAPIDS—The Amer. Can Co., 120 B'way, New York City, will soon award the contract for the construction of a factory on 6th St. Estimated cost, $1,000,000. M. M. Loony, 120 B'way, New York City, archt. and engr.

Minnesota

FREEPORT—The city engaged the Bradley Eng. Co., engr., St. Cloud, to prepare plans for a sewage system, including Imhoff tanks and sludge beds. Estimated cost, $30,000.

Missouri

MOBERLY—The city plans an election to vote on $250,000 bonds to construct a pumping and filtration plant, etc.

New Jersey

IRVINGTON—The Atlas Foundry Co. plans to construct a 60x60-ft. grey iron foundry addition, and is in the market for machinery for same. Estimated cost, $8,000. W. E. Lehman, Newark, engr. W. H. Mantz, genl. mgr.

New York

ALBANY—H. M. Biggs, State Comr. of the Health Dept. Laboratory, will soon receive bids for the construction of a 1-story, 31x85-ft. laboratory building. Estimated cost, $15,000.

BROOKLYN—The Natl. Lead Co., 111 B'way, New York City, has awarded the contract for the construction of a 4-story, 50x100-ft. factory on Marshall St., to the White Constr. Co., 95 Madison Ave., New York City, at $110,000.

BUFFALO—The F. F. Dally Co. of New York, 227 Military Rd., plans to construct a 1-story, 28x127-ft., addition to plant for the manufacture of blacking. Estimated cost, $6,000.

BUFFALO—The Linde Air Products Co., 1681 Fillmore Ave., plans to repair laboratory building recently destroyed by fire. Estimated cost, $4,000.

BUFFALO—The North Buffalo Hardware Fdry. Co., 743 Hertel Ave., plans to alter a 1-story, 67x350-ft., foundry. Estimated cost, $6,000.

BUFFALO—The University of Buffalo, 24 High St., is having plans prepared for a 3-story chemical laboratory. Estimated cost, about $300,000. McKim, Mead & White, 101 Park Ave., New York City, archts. and engrs.

NEW YORK—Sommerfeld & Steckler, archts. and engrs., 31 Union Sq., will receive bids about August 2 for the construction of a 7-story, 50x50-ft. factory for the Rigaud Perfume Co., 75 Barron St.

Ohio

AKRON—The Goodrich Co., South Main St., plans to build several buildings, including a water-softening plant, etc., on Rubber and Falor Sts. Estimated cost, $10,000,000.

CANTON—The city plans to construct a sewage disposal plant 10 miles south of here. Imhoff tanks will be installed in same. W. E. Sarver, city engr.

CANTON—The Timken Roller Bearing Co., Dueber Ave., will build a 1-story, 120x200-ft. factory addition to its tube mill for the manufacture of steel on Harrison Ave., S. W. Estimated cost, $40,000. Work will be done by day labor.

CINCINNATI—The Amer. Can Co., 120 B'way, New York City, has awarded the contract for the construction of a can factory, including a 6-story, 72x260-ft; 1-story, 60x1400 ft.; 1-story, 90x97-ft., and a 1-story, 80x160-ft., buildings, to the Ferro Concrete Constr. Co., Richmond and Harriet Sts. Estimated cost, $1,000,000. Noted April 14.

CLEVELAND—The city has awarded the contract for the construction of a filtration plant at the Baldwin Reservoir to R. E. Carey Co., West 112th St. Estimated cost, $312,360. Noted May 12.

CLEVELAND—The General Chemical Co., Warner Rd., S. E., has awarded the contract for the construction of a large addition to the national works of the company, including a sulphate of alumina plant, to the J. G. White Eng. Corp., 43 Exchange Pl., New York City.

CLEVELAND—The Hydraulic Pressed Steel Co., Hydraulic Ave., has awarded the contract for the construction of a 1-story, 75x200-ft., factory addition at 5704 Hydraulic Ave., to Craig Curtis Co., 1031 Guardian Bldg. Estimated cost, $75,000.

CLEVELAND—The Lake Erie Steel Co., Stop 13 A.B.C. line, has awarded the contract for the construction of a 1-story, 50x180-ft., steel mill addition, to the Republic Structural Iron Wks. Co., East 53rd St. Estimated cost, $75,000.

CLEVELAND—The Mechanical Rubber Co., Lisbon Rd., has awarded the contract for the construction of a 1-story, 34x102-ft., substation, to the Stone & Webster Co., Leader-News Bldg. Estimated cost, $100,000.

CLEVELAND—The Union Rolling Mills Co., 8200 Aetna Rd., had plans prepared for the construction of a 1-story, 22x182-ft. rolling mill addition. Estimated cost, $30,000. William Davis, 892 The Arcade, archt. and engr.

CLEVELAND—D. D. Wessels, 1385 East 173rd St., is having plans prepared for the construction of a 2-story, 100x110-ft., factory for the manufacture of concrete tubs, on East 21st St. and Oregon Ave. Estimated cost, $100,000. W. G. Caldwell, Park Bldg., archt.

COLUMBUS—The Atlas Brass Fdry. Co., 980 South Park St., has awarded the contract for the construction of a 1-story, 80x100-ft., brass foundry on Stewart Ave., to Nonnemachee & Frank, 427 Citizen Bank Bldg. Estimated cost, $20,000.

LORAIN—The West Shore Realty Co., care Holland Eng. Co., B. of L. E. Bldg., Cleveland, will soon award the contract for the construction of a sewer, water main and sewage disposal plant with two septic tanks. Estimated cost, $35,000.

OXFORD—The Miami University plans to build 3 buildings, including an addition to the Chemistry Building. Chemical equipment will be installed in same. Estimated cost, $125,000.

TROY—The Gummed Products Co. plans to construct a 2-story, 100x140-ft. factory on Market St. Estimated cost, $200,000.

Oklahoma

KELLYVILLE—J. W. St. Sing, clerk of the Bd. Educ., plans to build a 2-story high school here. A chemical laboratory will be installed in same. Estimated cost, $50,000.

OKLAHOMA CITY—The city is having preliminary plans prepared for the construction of a sewage disposal plant, etc. Estimated cost, $1,000,000. Fuller & McClintock, 170 B'way, New York City, engrs.

PERRY—The city is having preliminary plans prepared for the construction of a sewage disposal plant here. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., consult. engr.

Pennsylvania

JEANNETTE—The Amer. Window Glass Co., Farmers' Bank Bldg., Pittsburgh, has awarded the contract for the construction of a 1-story, 42x180-ft., cutting-room building, to the Bollinger-Andrews Co., Empire Bldg., Pittsburgh. Noted May 12.

PHILADELPHIA—John N. Gill Co., Otis Bldg., is constructing a factory to be used as a machine shop and erection shop for vacuum dryers and chemical machinery, on a 5-acre site near Cedar Grove Station on the Frankford Branch of the Philadelphia and Reading R.R.

PHILADELPHIA—The Prest-O-Lite Co., Inc., 30 East 42nd St., New York City, will receive bids until August 5 for the construction of a 1-story, 25x100-ft. acetylene plant, here. Estimated cost, $80,000. Noted April 7.

South Dakota

DE SMET—The Bd. Educ. is having plans prepared for the construction of a 2-story, 60x133-ft., high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. W. L. Alban, Endicott Bldg., St. Paul, Minn., archt.

Vermont

PROCTOR—The Vermont Marble Co. is building a marble sawing mill.

Virginia

RICHMOND—The Amer. Lace Leather Co., Virginia St., between 13th and 14th Sts., is having plans prepared for the construction of a building. Carneal & Johnson, Chamber of Commerce Bldg., archts.

RICHMOND — The Virginia-Carolina Chemical Co., 12th St., had plans prepared for the construction of a 5-story steel factory. Estimated cost, $250,000.

West Virginia

CHATTAROY—The Bd. Educ. plans to build a high school here. A chemical laboratory will be installed in same. Estimated cost, $100,000.

MARTINSBURG—The Natl. Shale Brick Co. plans to construct a brick plant. Estimated cost, $250,000.

WARWOOD — The Wheeling Cement Products & Building Co., 622 Wheeling

Bank & Trust Co. Bldg., Wheeling, will build a plant for the manufacture of building tile here. Estimated cost, $35,000. Work will be done by day labor.

Wisconsin

CUMBERLAND—The city is having plans prepared for the construction of a sanitary sewer system and treatment plant. Estimated cost, $80,000. L. P. Wolff, Guardian Life Bldg., St. Paul, Minn., engr.

RACINE—The Hamilton Beach Mfg. Co., Rapids Drive, is having plans prepared for the construction of a 1-story, 80x200-ft. foundry. Foundry equipment will be installed in same. Estimated cost, $60,000. A. L. Tiegel, Baker Block, archt.

WAUKESHA—The Waukesha Casting Co., 340 B'way, is having plans prepared for the construction of a 1-story, 120x130-ft. foundry. Estimated cost, $50,000. C. Kawin Co., 431 South Dearborn St., Chicago, engr.

Quebec

CHELSEA—The Royal Securities Co., 164th and St. James Sts., will receive bids in August for the construction of a pulp and paper plant here. Noted April 21.

MONTREAL—The Pottery Co., Ltd., has purchased a large site in the eastern section of the city and plans to construct a plant on same. The company is in the market for additional kilns.

Ontario

LONDON—The Bd. Educ., 848 Dufferin Ave., will receive bids until August 1 for the construction of a collegiate building on Waterloo St. Physics and chemistry laboratory equipment will be installed in same. Estimated cost, $500,000. L. V. Carrothers, Hydro Bldg., archt.

WINDSOR—C. W. Ripley, 519 Sandwich St., plans to build a foundry on Sandwich St. Estimated cost, $25,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

FOREST PRODUCTS LABORATORY will hold its decennial celebration at Madison, Wis., July 22 and 23, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

INSECTICIDE AND DISINFECTANT MANUFACTURERS' ASSOCIATION will hold its midsummer meeting at Boston, July 15 and 16.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its Fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

Industrial Notes

PARSONS, KLAPP, BRINCKERHOFF and DOUGLAS announce the removal of their general and engineering offices from 60 Wall St. to their own building at 84 Pine St., New York.

THE GENERAL FIRE PROOF CO., Youngstown, Ohio, devotes its May issue of "General Fire Proofing" to the problem of industrial housing and contains examples of recent projects.

THE STOKER MANUFACTURERS ASSOCIATION recently held a meeting at Lakewood, N. J., at which the following officers and executive committee were elected: Sanford Riley, president; M. Alpern, vice-president; A. G. Pratt, treasurer, S. A. Armstrong and H. A. Hatton, on the committee, and J. G. Worker, secretary.

HARRY LEVEY, INC., has been organized as the first motion picture producing company which will devote itself exclusively to the making of industrial and educational motion pictures. Arrangements have already been made for the production of a series of pictures showing the making of dyes, explosives, automobiles, airplanes, paints, leather and electrical apparatus. Temporary offices are at the Hotel Astor, New York. Production studios are at 109 East 124th St., New York.

THE INTER-RACIAL COUNCIL, Woolworth Building, New York City, has established an information service for the benefit of employers of foreign born labor and for the workers themselves. The object of the service is to stabilize immigrant labor and to promote better relations between the various races in America and native born. The service will also check the tendency of the foreign born to return to their native land under the mistaken impression that prices are lower and living conditions better than in America.

THE GENERAL BRIQUETTING CO., New York, announces the appointment of Thomas F. Kelly, formerly with the Lackawanna Steel Co., as sales engineer of the flue dust, ore and by-products department.

THE CRESCENT BELT FASTENER CO., New York, has recently published a booklet on "Moden Scientific Methods of Belt Joining" which contains many practical data to those interested in the maintenance of production schedules and continuous performance of machines where belting is used. Instructions are given which will enable anyone to make belt joints, retaining the belt's full strength and assuring long life. Essential data are presented on a single sheet which can be suitably displayed on the wall. Copies of this illustrated circular will be sent upon request.

W. J. RAINEY, INC. is the name of the new incorporation of the business heretofore carried on under the name of W. J. Rainey, as announced by the Trustees of the Estate of W. J. Rainey. The officers of the new corporation are: Roy A. Rainey, chairman of the board, Scott Stewart, president and treasurer; L. L. Willard, vice-president in charge of operations; John McElwain, vice-president in charge of sales and purchases of raw materials; H. R. Ahrens, secretary. The executive offices of the company will remain at 52 Vanderbilt Ave., New York."

THE CHICAGO PNEUMATIC TOOL CO., New York, announces the election of Allan E. Goodhue as vice-president in charge of sales. Mr. Goodhue since May 1, 1919, has been managing director of the company's English subsidiary, The Consolidated Pneumatic Tool Co., London, England; also director of European sales for the Chicago Pneumatic Tool Co. He sails for New York on the "Olympic" and is scheduled to arrive about July 3.

SKF INDUSTRIES, INC., at a special meeting held May 13, 1920, accepted the resignation of B. G. Prytz, as president. Mr. Prytz has been elected managing director of the parent company, with headquarters at Gothenburg, Sweden. At the same meeting F. B. Kirkbride, vice-president since the organization of the company, was elected president.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., reports an order for a 1-ton "Greaves-Etchells" furnace for the Buenos Ayres Western Ry. Ltd.

THE WICKWIRE SPENCER STEEL CORP., Buffalo, N. Y., which publishes "Wick-Tack" has issued a very interesting number for June, 1920, which contains items on the personnel of the company, association activities, articles and editorials.

J. G. WHITE ENGINEERING CORP. announce that they have received a commission to build a very large addition to the National Works of the General Chemical Co. at Cleveland, Ohio. One of the most important features of the addition will be a sulphate of aluminum plant of large capacity. The engineers have been working on the engineering plans for some months and it is expected that the construction work will be started at an early date.

FRANK L. MCCARTNEY, formerly New York branch manager for the Monsanto Chemical Co., has been appointed general sales manager, with complete charge of all sales for all plants, including branch houses.

JOS. RISEMAN & CO., 152 Broadway, N. Y., announce that their business will be carried on from the new address given herewith.

BLAW-KNOX CO. announce that "Blawnox" is the new name conferred by the United States Senate upon the town of Hoboken, Pa., the home of the company. The company first established in Hoboken about five years ago, occupying a comparatively small shop, at the same time operating another plant at Wheatland, Pa. About two years ago the latter plant was removed and added to the Hoboken works. The magnitude of the works has since increased by the erection of a large hammer-welding plant, augmenting the already extensive oxy-acetylene and electric welding facilities of Blaw-Knox Company. About 1,000 persons are employed in the shops, most of whom live in Old Hoboken. A petition signed by the people of the town, asking the Senate to change the postoffice name to Blawnox, has just been granted. This company also announces that Dewitt Clinton Grove, past vice-president of the Technical Publicity Association, has become advertising manager of the company. He succeeds George Land, who resigned July 1, to enter the agency field as head of the Technical Publicity Co. of Pittsburgh.

THE SWENSON EVAPORATOR CO. of Chicago is selling a large evaporator for export to Chile to be used in research for the production of Chilean nitrate.

THE DETROIT ENGINEERING SOCIETY entertained a Swiss delegation of sixty-five members in Detroit recently. The party made a thorough inspection of industrial plants in and about Detroit.

ARTHUR R. MAAS LABORATORIES, Los Angeles, Cal., has issued a twenty-two page pamphlet entitled "Chemistry and You," which has been issued for the purpose of acquainting those interested with their business, Chemical Service. The laboratories are equipped to handle problems related to industrial developments on the Pacific Coast, "from test tube to factory," having a well equipped laboratory and the necessary apparatus to test out processes on a semi-commercial scale. Arthur R. Maas is in charge of the organization; E. L. Campbell is chief chemist, R. B. Stringfield is in charge of chemical and H. L. Glaze of the mechanical engineering problems.